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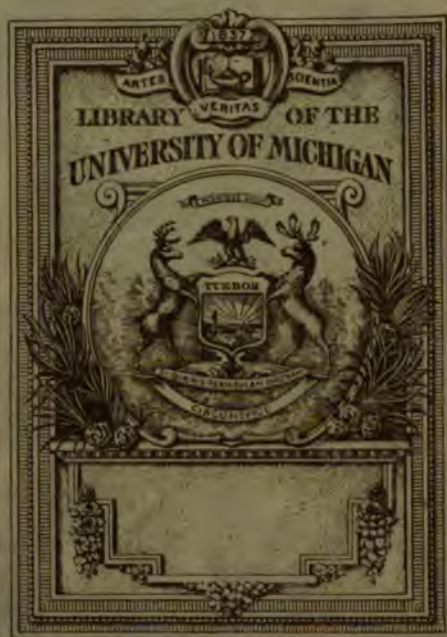
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UNITED STATES  
COAST AND GEODETIC SURVEY

F. M. THORN  
SUPERINTENDENT

METHODS AND RESULTS

SECULAR VARIATION OF THE MAGNETIC DECLINATION

IN THE  
UNITED STATES

AND AT SOME FOREIGN STATIONS

[SIXTH EDITION]

WITH FIVE PLATES

APPENDIX No. 12—REPORT FOR 1886



WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1887

QC  
228  
438  
1987



## APPENDIX No. 12.—1886.

### THE SECULAR VARIATION OF THE MAGNETIC DECLINATION IN THE UNITED STATES AND AT SOME FOREIGN STATIONS.

[New and greatly enlarged edition.]

By CHARLES A. SCHOTT,  
*Assistant, Coast and Geodetic Survey.*

[Sixth edition, April, 1887.]\*

#### INTRODUCTION.

The practical nature of the inquiry, and the necessity of looking to the publications of the Coast and Geodetic Survey to supply the latest information on the subject of the changes, secular and otherwise, of the direction of the magnetic needle, has caused an ever-increasing demand for these investigations of the survey, and this has acted again as a stimulus to advance our knowledge of the secular changes of the magnetic force, both for direction and intensity. It thus becomes necessary every few years to re-discuss or submit to analysis any additional observations, as well as to direct such observations to be made at those places where they may contribute most effectively towards the elucidation of the laws of change.

Appendix No. 6, Coast and Geodetic Survey Report for 1885, contains an exhaustive article on the secular change of the magnetic dip and the magnetic intensity, as observed in the United States from the earliest to the present time. It is accompanied by three maps, showing the actual distribution of these magnetic elements for the epoch 1885-0. This, together with the present communication, completes the inquiry in this branch of knowledge by bringing it up to date.

During the five years which have elapsed since the last issue of this paper the available material for the discussion of the secular variation of the declination has greatly increased, bringing up the number of stations contained in this edition to 94 and the number of declinations to 1071, for each of which full reference is given, as well as a comparison of the observed and computed values. The average number of observations for a station is 11. It is satisfactory to remark that this increase of observations was found greatly to improve the values of the analytical expressions, giving greater accuracy to the results deduced and tending to greater uniformity in such phases of the secular variation as the amplitude of the motion and the epochs of maxima and minima or times of magnetic elongation, all of which depend on the geographical position of the stations.

\* This article originally appeared in Coast Survey Report for 1859, Appendix No. 24, pp. 296-305. In the second edition, in Coast Survey Report for 1874, Appendix No. 8, pp. 72-108, the investigation appears greatly extended; the substitution of a sine for a cosine function was made and the epoch was changed from 1830 to 1850; also some use was made of Cauchy's method of interpolation for the establishment of some second periodic terms. The third edition, issued in June, 1879, appeared in pamphlet form, and is not contained in any annual report of the Coast and Geodetic Survey. The geographical range of the investigation was much enlarged, and the paper was illustrated by two plates. The next or fourth edition was brought out in June, 1881, and forms Appendix No. 9, Coast and Geodetic Survey Report for 1879, then passing through the press; it was illustrated with three plates. In the fifth edition, of November, 1882, Appendix No. 12, Report for 1882, there were discussed 837 declinations, observed at 82 stations, situated in the United States and a few in Europe, South America, Asia, and Polynesia, the latter for the purpose of extending our knowledge of magnetic changes beyond our immediate sea-coast.

In the collection of observed declinations, as heretofore given, I had sparingly made use of observations taken on board ship, introducing such observations only from necessity, *i. e.*, in the absence of observations on land; but in the present discussion trustworthy observations made at sea have been more freely introduced, and in the case of the great number of observations by Spanish navigators towards the close of the past century, along our Pacific coast, their united testimony has greatly benefited our range of knowledge by giving greater security and unity to results which before appeared doubtful or scattered. The collection of this material is contained in Appendix No. 7, Coast and Geodetic Survey Report for 1885, and was communicated by Assistant G. Davidson. Its value was then conjectural, but the present discussion of it proved to be highly creditable to the navigators of that period. I find the average probable uncertainty\* of a declination (variation of compass) observed on board the wooden hulls of those times not to exceed  $\pm 1^\circ$ , the same as I had assigned to the observations taken by Vancouver, an amount which probably represents the best practice of that epoch.

In our own times, for vessels composed of iron and steel, and otherwise largely supplied with such metal, when swung on, say, 8 or 32 equidistant points of the compass, the observed declination will still be subject to a probable uncertainty of about  $\pm 0^\circ.5$  to  $\pm 0^\circ.3$ .

The immediate object of the discussion of the secular change of the declination is to furnish the means of referring observed declinations from one epoch to another, as, for instance, when surveyors are required to re-trace and re-discover old lines originally run by compass, but which had become obliterated in the course of time, or when the variation is demanded for the compasses placed on the sailing, coast, and harbor charts of the survey. The principal demand for the results of this article comes from surveyors and members of the legal profession, and frequently arises from litigation in cases of disputed land boundaries; and since the source where such information could be had became better known, the number of applications to the survey for assistance has increased from year to year.

To facilitate reference to stations and results, the contents of the paper are arranged in three parts—an eastern, middle, and western division—in which the places follow approximately in geographical order; and the final tables, or ephemerides, give the declinations, after the year 1850, for every fifth year, instead of for every tenth as in former editions. To render this investigation more useful to practical men, I have thought it desirable to preface it with a brief account of the principal motions, systematic as well as apparently irregular, to which the direction of the magnetic needle has been found subject, in order to clearly separate and distinguish these changes from the secular variation, which last is here the special object of treatment.

*The magnetic declination.*—The magnetic declination (or variation of the compass, as it was formerly called by surveyors and still is by navigators), at any place, is the angle contained between two vertical planes, one being the astronomical or true meridian, and the other a plane in which the horizontal axis of a freely suspended magnet lies at the time. The former plane is fixed and the latter variable, since it is found that the needle is generally in a state of slow or tremulous motion. The magnetic declination varies with respect to space and time; it is, therefore, necessary to give with the statement of its measure the exact time (year, day, and hour) when an observation was made, as well as the geographical position of the place (the latitude and longitude to the nearest minute of arc will suffice). The declination is called “west” when the *north* end of the magnet points to the west of true north; algebraically this fact is indicated by a + sign, and if “east” by a – sign. It is a matter of observation that the magnet, when light and delicately suspended (by a single fiber of raw silk) is seldom or never at rest, but is always shifting its direction, or is in a state of oscillation or of tremor, or it may be subject to sudden changes. These angular motions have been classified as regular (periodic) and irregular variations, and of these we propose to notice briefly the principal ones, such as may generally be exhibited within the limits of the United States.

The *solar-diurnal* variation consists in a systematic movement of the magnet, having for its period the solar day. Its phases depend on local time and its character is the same for the greater part of the northern hemisphere; viz, about the time of sunrise the *north* end of the needle is

\* Used in the sense of probable error in the method of least squares.

generally found approaching to or near its most *easterly* deflection or elongation from the magnetic meridian. This phase happens, for instance, at Philadelphia, on the yearly average, about 7 $\frac{3}{4}$ <sup>h</sup> a. m.; at Key West, Fla., about 8 $\frac{1}{4}$ <sup>h</sup> a. m.; and the same at Madison, Wis. It is subject to an annual variation, being about three-quarters of an hour later in the months when the sun is south of the equator, and about one-half of an hour earlier in the summer months than its yearly average time of occurrence. The north end of the needle then begins its principal daily motion, and reaches the opposite extreme position, or its western elongation, about half past 1 o'clock p. m. It is reached a few minutes earlier in summer and a few minutes later in winter, and hardly varies half an hour for different localities. After this epoch the needle takes up an easterly movement and gradually returns nearly to the direction from which it set out in the morning. Frequently an interruption, or small reversed motion, is exhibited during the night. At Philadelphia the average daily direction is reached in summer about 10 $\frac{1}{4}$ <sup>h</sup> a. m. and in winter about 10 $\frac{3}{4}$ <sup>h</sup> a. m., and generally within half an hour of these times at other places. The magnetic meridian is crossed a second time, generally between 7 and 9 p. m. The angular range between the morning and afternoon elongations, or the diurnal range, is about 8' on the average at Philadelphia and about 5 $\frac{1}{2}$ ' at Key West; in higher magnetic latitudes it is more, in lower less. This range is subject to an annual inequality, being much more conspicuous in summer than in winter (10 $\frac{1}{2}$ ' at Philadelphia in August and 6' in November). It is further subject to a periodic inequality related to the eleven-year cycle of the sun-spots. It is least in years of minimum sun-spots (as in 1878 and 1887 (?), for instance) and greatest in years of maximum sun-spots (as in 1870 and 1883), the factors being 0.7 and 1.3, about, of the average amount of these years respectively. This daily variation appears at times intensified, at other times enfeebled, and during the winter months there are occasionally days on which it cannot be recognized. Observations must be corrected for time of day in order to reduce the result to the average direction of the twenty-four hours; a table given for this purpose is found in Coast and Geodetic Survey Report for 1881, Appendix No. 8, Art. 6.

The *annual variation* of the declination is so small that a mere mention of its existence suffices; its amplitude is at most 1 $\frac{1}{2}$  minutes of arc.

The *variation* depending on the *solar rotation* has a period of about twenty-six days; its amplitude is likewise small in our latitude.

*The lunar inequalities*: These we also pass over on account of their small amplitude. The principal inequality is the lunar diurnal variation exhibiting the peculiarity of two maxima and two minima on each lunar day. The range of this inequality at Philadelphia is about 27'', and at Toronto, Canada, about 38'. Other lunar inequalities are of yet smaller order.

*The secular variation* of the magnetic declination, our subject proper, is most probably also of a periodic character, but since it requires centuries for its full development, and since, as yet, no one cycle has actually been completed within the range of observation, we are obliged, in the absence of any reliable theory, to follow up the phenomena by continuous observations. The secular motion may be compared with a wave motion or with an oscillation of a pendulum which comes to rest momentarily at its extreme positions or elongations and moves fastest midway between these extremes. Smaller variations within this period have also been detected, but the general angular movement (say of the north end) of the magnet may be described as follows: About the times of maximum deflection the magnet appears almost stationary or only slowly oscillating about the same average direction for several years (as observed by ordinary or rough instruments); soon, however, the effect of the secular change becomes perceptible, increasing gradually, year by year; this progressive angular motion soon reaches an annual maximum value, after which, still moving in the same direction, it slowly diminishes in speed and finally becomes again stationary, now at the opposite extreme digression, after which possibly it will return again to its first position. Within the area of the United States and south of latitude 49° a complete oscillation of this kind may require between two and a half and three and a half centuries, during which time the magnet would swing twice, i. e., once forward and once backward, through an arc of several degrees, generally keeping within the limits of 4° and 8° of total range for our geographical boundaries; in other localities the period and range are very much greater. The remarkable regularity of the motion is well shown on the accompanying diagram for Paris, France, for which place we probably possess the longest series of observations; the period is about four and two-third cen-

turies, and the range nearly  $33^\circ$ . To illustrate further the effect of the secular change, we may take the case of New York City. In this locality the needle was observed to be in nearly a stationary condition about 1682, its north end pointing then fully  $9^\circ$  to the west of north; it then moved easterly and reached its easternmost digression about 1799, showing at that time only  $4\frac{1}{2}^\circ$  west declination. Ever since this epoch the motion has been westerly, its present value being nearly  $8\frac{1}{2}^\circ$  W.; the greatest annual change (nearly  $5'$ ) was apparently passed about the middle of the century. The times of these stationary epochs are different at different localities; the last epoch of eastern elongation was noted earliest in Maine towards the close of the past century, later in the Mississippi Valley, and it has now reached the coast of California and Washington Territory. At present over nearly the whole of the United States the effect of the secular change is to *increase* west declination, or (what is the same) to *decrease* east declination; but on parts of the Pacific coast and for some short distance in the interior the effect is still opposite, viz, an *increase* of east declination. Alaska, however, is to be excepted; there easterly declination is now slowly decreasing. There must, consequently, be a region or belt of no change at present, which will be referred to in detail further on. It is this regular motion, known as the secular variation, which renders it necessary to reconstruct isogonic charts from time to time and to change the compasses and magnetic bearings on our charts. Although this secular variation is perfectly systematic it may not always appear so, especially when deduced from few observations made at different places in the same general locality, either on account of small observing errors or in consequence of local deflections, or for the reason that ordinary periodic variations and inequalities have not been fully eliminated from the results. Among the latter irregularities must be classed the—

*Magnetic disturbances or storms.*—These may occur at any time, and are, when taken individually, beyond the power of prediction; but attacked by the statistical method, *i. e.*, when classified and when averages are taken of many thousands, they are found to be subject to various laws. Their presence is generally indicated by sudden deflections, and by rapid and great fluctuations in the direction of the needle as compared with its normal position, which otherwise might have been expected at that time of day and month. They often take place simultaneously over distant regions of the globe, and in duration may be confined to a few hours, or they may last a day or even for several days. They are frequently accompanied by auroral lights and by strong electric earth-currents. When analyzed in large numbers they exhibit a solar-diurnal variation, the westerly and easterly disturbances, however, following different laws. They also have an annual variation and seem to depend largely on the sun-spot period or an eleven-year cycle. Irrespective of direction of the disturbing forces the most disturbed hours of the day are generally those between  $7^h$  and  $10^h$  a. m., and the least disturbed those between  $2^h$  and  $6^h$  p. m. Westerly disturbances occur most frequently about  $8^h$  a. m. and least about  $8^h$  p. m.; they exhibit a *single* daily progression. Easterly disturbances reach a maximum about  $8^h$  p. m. and a minimum about  $2^h$  p. m.; they exhibit a *double* daily progression. Westerly and easterly disturbances appear to agree in their annual variation, in their times of maxima, *i. e.*, in August, September, and October, and in their times of minima, *i. e.*, in January and June. The disturbances are most frequent and considerable in the years of maximum sun-spot activity and the reverse in years of minimum sun-spots. The following table of the observed disturbances, in a bi-hourly series at Philadelphia in the years 1840 to 1845, will give an idea of their relative frequency and magnitude:

| Deviations from normal direction. | Number of disturbances. |
|-----------------------------------|-------------------------|
| $3'.6$ to $10'.8$                 | 2189                    |
| $10'.8$ to $18'.1$                | 147                     |
| $18'.1$ to $25'.3$                | 18                      |
| $25'.3$ to $32'.6$                | 3                       |
| Beyond                            | 0                       |

At Key West, Fla., the maximum deflection noticed between 1860 and 1866 was  $21'.4$ . At Madison, Wis., where the horizontal magnetic intensity is considerably less, very much larger deflections have been noticed. Thus, on October 12, 1877, one of  $48'$ , and May 28, 1877, one of  $1^\circ 24'$ .

We now proceed to the consideration of the secular variation of the magnetic declination.

*Historical note.*—The following brief historical remarks on the magnetic declination and its secular variation have been prepared from extracts from Humboldt's *Cosmos* (Otte's translation, London, 1849–1858), Vol's II and V; from the *Encyclopædia Britannica*, 9th edition, Art. Compass, vol. VI (Boston, 1877), and from E. Walker's treatise "Terrestrial and Cosmical Magnetism," Cambridge (England), 1866, in which works fuller references will be found. The *Encyclopædia of Experimental Philosophy*, London, 1848, Art. Magnetism, as well as Gehler's *Physikalisches Wörterbuch*, Leipzig, 1825, Art. Compass, were also consulted.

The first notice of the magnetic needle as applied to navigation we meet with among western (European) nations does not date further back than the eleventh or twelfth century of our era, but in China the directive property of the magnetic needle was made use of on land as early as the twelfth century B. C., and, according to tradition, even at a very much earlier time (2634 B. C.). In the third and fourth centuries of our era Chinese vessels were guided by the magnetic needle, and through them a knowledge of the polarity of the needle was conveyed to India and thence westward. In the ninth century Chinese merchants traded in ships to the Persian Gulf and the Red Sea. Probably through the influence of Arabian navigators, or through the agency of the Crusaders, the use of the mariners' compass was introduced into Eastern Europe. Among the first European writers of the middle ages who refer to the loadstone or to the compass is the Icelandic historian, Are Frode, who lived about the end of the eleventh century. He states that the directive property of the loadstone was then known to seamen in northern countries. Next are mentioned, Alexander Neckam, in two treatises, "De Utensilibus" and "De Naturis Rerum," of the twelfth century, Guyot, of Provins, in 1190, and Jaques de Vitry, between 1204 and 1215. Raymond Lully, in 1272 and 1286, remarks that the seamen of his time employed the magnetic needle, and from Torfæus we learn that the compass was in use among the Norwegians about the middle of the thirteenth century. Among then-western nations the construction of the instrument underwent great improvements, particularly by the hands of Flavio Gioja, of Amalphi, Italy, in 1302.

*The declination.*—From a Chinese work, written between 1111 and 1117 A. D., we learn that the needle was then suspended by a thread and that the mode of measuring the amount of the declination, it being then west (or, as there expressed, east of south), had long been understood. It can hardly be supposed that the fact of the needle, in general, *not* pointing exactly to the true north and south could have been overlooked in the twelfth century, on the Mediterranean, in places where the declination reached  $6^{\circ}$  to  $10^{\circ}$ . A passage interpolated in a Paris MS., a copy of "Epistola Petri Peregrini," &c., of 1269, states the declination to have been determined by him in Italy at  $5^{\circ}$  E. Columbus probably was the first who records the change in the sign of declination with change of geographical position. On starting from the west coast of Spain he had east declination. In September, 1492, in the Atlantic, in latitude  $28^{\circ}$  longitude  $28^{\circ}$  (about) he observed  $11^{\circ}$  W. He has also the merit of being the first to discover a part of an agonic line, or line of no declination. The first scientific work in Europe in which the declination is treated at any length and deduced from actual observations is that by Boronghs, published in 1581, entitled "A discourse on the Variation of the Cumpas or Magneticall Needle," and is dedicated to the "travailleurs and mariners of England." In 1599, Prince Maurice, of Nassau, the lord high admiral of the Low Countries, recommended seamen to keep a register of the declination in every part of the world they might visit.

*Isogonic charts.*—The declination only was marked on the chart of Andrea Bianco, drawn up in the year 1436, but Alonso de Santa Cruz, in 1530, constructed the first general declination chart, though based upon very imperfect material. Upon the chart by Father Christopher Burrus (who died in 1632), published at Lisbon, the magnetic lines are called "tractus chalyboeliticos." About 170 years after Alonso de Santa Cruz, Edm. Halley published his celebrated isogonic chart for the year 1700, based entirely upon observations. [Tabula Nautica, Variationum Magneticarum Index, juxta observationes anno 1700.] His voyages of the years 1698, 1699, and 1702 were undertaken at the expense of the British Government. This chart comprises the areas of the North and South Atlantic, the Indian, and the extreme western part of the Pacific Ocean. Isogonic charts became quite numerous after Halley's time. Those by Hansteen (*Magnetismus der Erde*, 1819) deserve special mention; his earliest one is for the year 1600. In 1838 Gauss published his "General theory of Terrestrial Magnetism" (in *Resultate, etc., des Magnetischen Vereins*, Göttingen) and the result-

ing isomagnetic curves were afterwards charted. A translation of the theory and copies of the charts are given in Taylor's Scientific Memoirs, Vol. II, London, 1841. In the work of A. Erman and H. Petersen, "The Foundation of the Gaussian theory and the phenomena of Terrestrial Magnetism in the year 1829," Berlin, 1874, the general distribution of magnetism over the globe is shown on six charts for the epoch 1829. For the most complete magnetic charts depending directly on observations, the reader is referred to General Sir Edward Sabine's Contributions to Terrestrial Magnetism, Nos. XI, XIII, XIV and XV, Phil. Trans. Roy. Soc., for the years 1868, 1872, 1875 and 1877, respectively. These charts refer to the period 1840 to 1845. The latest isogonic charts for the United States of America, reduced to the epoch 1885.0, will be found in the Coast and Geodetic Survey Report for 1882, Appendix No. 18, in three sheets, Nos. 38, 39, 40.

*The secular variation of the declination.*—The discovery of the gradual change of the declination, which for any one place had previously been supposed by philosophers to be constant, is due to Gellibrand, of Gresham College, England. In 1635 he published his work, entitled "A discourse mathematicall on the Variation of the Magneticall Needle, together with its admirable diminution lately discovered." He based his conclusions upon the recorded observations of Boroughs (1580), of Gunter (1622), and his own observations (1633–34), showing that in the vicinity of London the direction of the needle had changed in the interval fully  $7^\circ$  to the westward. From this time the fact of the secular variation was completely established, and it remained to later times to determine its extent and develop the law governing this change, and to endeavor to find its cause. That the velocity was not uniform was soon perceived, and the apparent periodic character of the variation was prominently forced upon the attention of observers when the needle reached a stationary condition, as, for instance, in the eastern part of the United States towards the end of the eighteenth century, and then recommenced its motion in a direction *opposite* to that it had before. Similarly at Paris, France, the secular change was westward between the stationary epochs of 1580 (about) and 1812 (about), since which time the needle has commenced retracing its course eastwardly. Nearly midway between such stationary epochs the annual change is observed to be a maximum. See Plate No. 29, upper diagram.

#### ANALYTICAL EXPRESSION OF THE SECULAR VARIATION OF THE MAGNETIC DECLINATION.

*The secular variation* can be represented with considerable accuracy by means of a circular harmonic function, as might be expected from the almost unlimited adaptation of such functions to all forms of periodically recurring phenomena, provided a sufficient number of terms are introduced. The formula employed for our purpose may be written—

$$D = \delta + r \sin(\alpha m + c) + r_1 \sin(\alpha_1 m + c_1) + r_{11} \sin(\alpha_{11} m + c_{11}) + \dots$$

Where  $D$  = magnetic declination at any time  $t$ , positive when west, negative when east.

$m$  = number of years and fractions of a year from an epoch  $t_0$  for which 1850 has been adopted; hence  $m = t - 1850.00$

$\alpha, \alpha_1, \alpha_{11}, \dots$  are factors depending on the adopted periods  $p, p_1, p_{11}, \dots$  of the several

terms; so that  $\alpha = \frac{360^\circ}{p}$      $\alpha_1 = \frac{360^\circ}{p_1}$      $\alpha_{11} = \frac{360^\circ}{p_{11}}$ , etc.

Thus to  $\alpha = 0.9, 1.0, 1.2, 1.5$  there correspond periods of 400, 360, 300 and 240 years respectively.

$r, r_1, r_{11}, \dots$  are parameters or semi-ranges,

$c, c_1, c_{11}, \dots$  epochal constants of the several periodic terms.

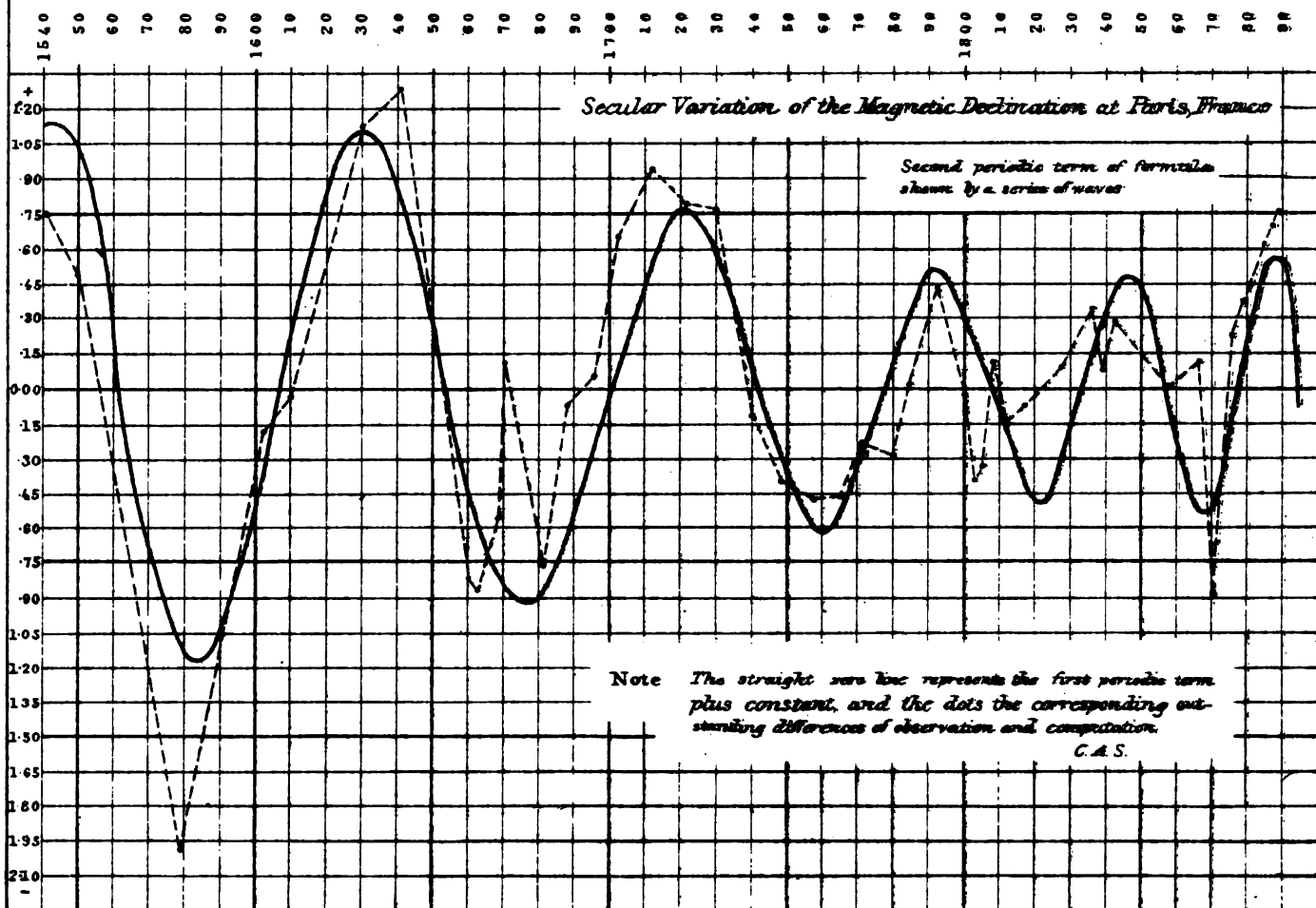
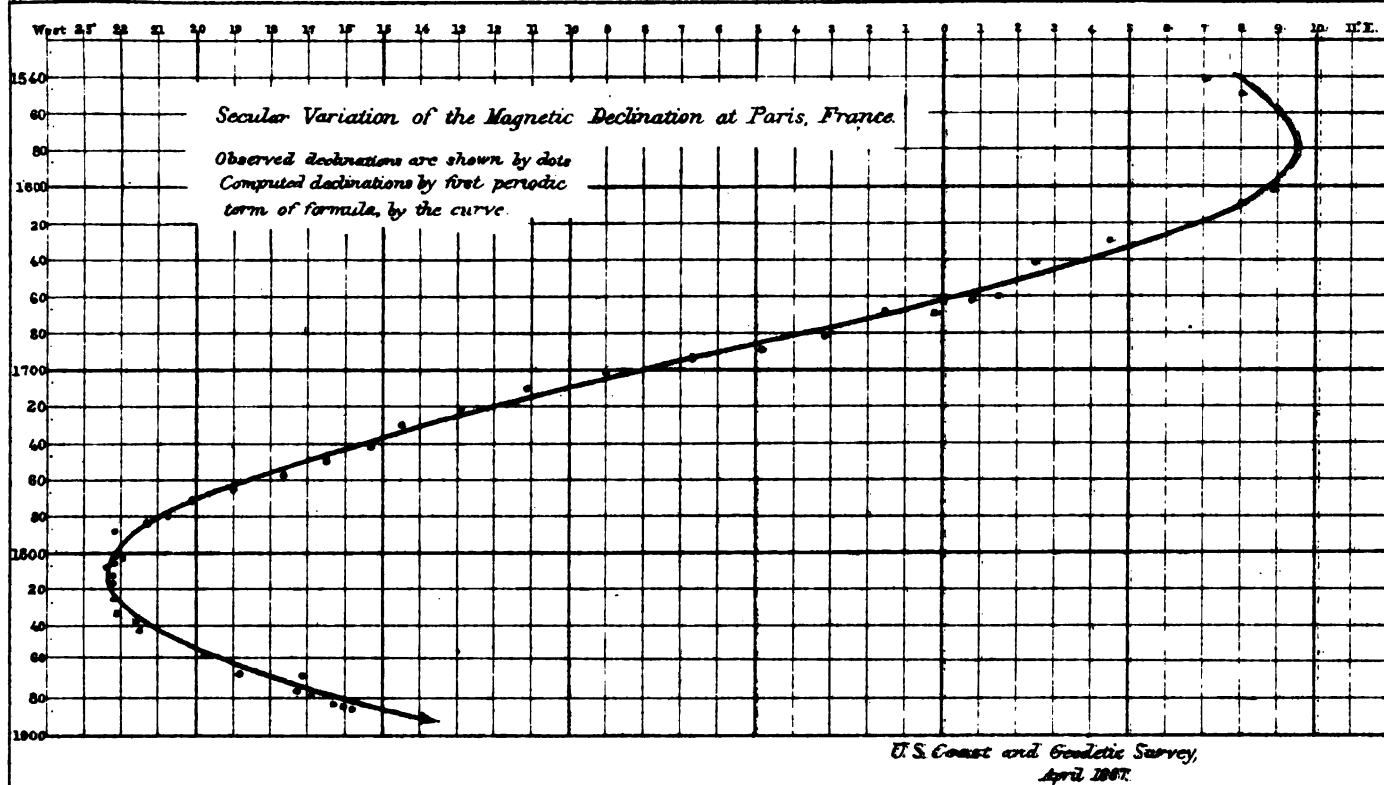
$\delta$  = a constant, representing the average or normal declination about which the periodic fluctuations take place.

The quantities  $\delta, r, r_1, r_{11}, \dots, \alpha, \alpha_1, \alpha_{11}, \dots$  and  $c, c_1, c_{11}, \dots$  for any one locality must be determined from the observations made there at various times, and their most probable values are to be deduced by application of the method of least squares.

We begin by assuming a suitable value\* for the length of the principal period, and the first periodic term of the formula is treated as follows:

Put  $\delta = \delta_0 + x$  where  $\delta_0$  = an assumed approximate value of  $\delta$  and  $x$  a correction to it; also put  $r \cos c = y$  and  $r \sin c = z$ ,

\* It may be found graphically in the first instance.





then the conditional equations will take the form :

$$0 = \delta - D + x + \sin \alpha m . y + \cos \alpha m . z + \dots$$

from which the numerical values of  $x y z$  are to be deduced in the usual way by means of normal equations. To determine the value of  $\alpha$  (and similarly of  $\alpha, \alpha, \dots$ ) the computation is repeated three times (or more if necessary) using the slightly changed values  $\alpha + \Delta\alpha$  and  $\alpha - \Delta\alpha$ , from which that particular value of  $\alpha$  is found and finally retained which renders the sum of the squares of the differences of observed and computed declinations a minimum. In some cases where certain observations were evidently less trustworthy than others, and which nevertheless could not be dispensed with owing to the small number of observations, or on account of their special value with reference to time, particular weights were assigned; generally each observation received the weight unity, a few imperfect observations the weight one-half, and to some specially valuable observations double weight was assigned. In these cases the conditional equations were multiplied by the square root of their respective weight. Of observations evidently grossly in error no notice whatever was taken. In finally selecting what seemed to be the best expression for the secular change at a station, I have also frequently been guided by the accord of the various constants entering into the equation when compared with corresponding values in the equations for surrounding stations. When applying Cauchy's method of interpolation the form

$$D = \delta + r \cos c . \sin m \alpha + r \sin c . \cos m \alpha + \dots$$

was found more convenient in use. This method was employed for establishing such second or third periodic terms as appeared demanded by the observations, but only a few such terms could be determined and they generally failed in consequence of the insufficiency in number of data or for want of sufficient accuracy in the observations.

The annual change  $v$  of the magnetic declination due to the secular motion, positive when increasing west declination (or decreasing east) and negative when in the opposite direction; also the epoch of minimum west declination (or of maximum east); also the amount of the declination at this epoch and the apparent probable error of an observation—are found as follows:

Differentiating the expression for  $D$ , we have

$$dD = r\alpha \cos (\alpha m + c) dm + r, \alpha, \cos (\alpha, m + c,) dm + \dots$$

hence for any time  $t$  and for minutes of arc,

$$v = 60 \sin 1^\circ [r\alpha \cos (\alpha m + c) + r, \alpha, \cos (\alpha, m + c,) + \dots]$$

Maxima and minima are deduced from the equation:

$$0 = r\alpha \cos (\alpha m + c) + r, \alpha, \cos (\alpha, m + c,) + \dots$$

from which expression  $m$  can be found.

The apparent probable error  $e_0$  of an observation is deduced from the differences  $\Delta$  of the observed and computed declinations by the formula  $e_0 = \sqrt{\frac{0.455 \sum \Delta^2}{n - n_1}}$ , where  $\Sigma$  indicates summation and  $n$ , equals the number of unknown quantities in the expression for  $D$ , as determined from the observations themselves; when weights  $p$  enter, we substitute  $p \Delta^2$  for  $\Delta^2$  and then obtain the probable error of an observation of unit weight. The greater part of this apparent probable error or rather probable uncertainty in the representation is due to the fact that the observations collected at any one place were not generally made at precisely the same spot, thus introducing the effect of any local irregularities in the distribution of magnetism in addition to the ordinary observing errors. In cases of observations evidently not corrected for diurnal variation, with the hour of the day of observation not known, the received imperfect value had to be accepted. This remark, however, applies only to otherwise accurate measures for which alone this correction is of importance.

There are some stations where from want of a sufficient number of observations, or from shortness of interval between the first and last observation, the length of the period of the secular variation could not be made out. In such cases the declination and *annual change* due to the secular motion may be expressed by means of an exponential function, thus:

$$D = d_0 + y(t - t_0) + z(t - t_0)^2 + \dots$$

where  $d_0$  = magnetic declination at epoch  $t_0$ . I adopt, as in the preceding formulæ,  $t_0 = 1850.0$  and put  $d_0 = \delta + x$ , where  $\delta$  = an approximate value of  $d_0$  and  $x$  a correction to it to be determined, as well as  $y$  and  $z$ , &c., from the observations themselves. For this purpose we have a number of conditional equations of the form

$$0 = \delta - D + x + ym + zm^2 + \dots$$

which equations are to be treated, as customary, by the method of least squares.

Let  $D$  = resulting magnetic declination  $\left\{ \begin{array}{l} + \text{ when } W \\ - \text{ when } E \end{array} \right\}$  for the time  $t$

$a$  = annual change =  $y + 2z(t - t_0) = y + 2z \cdot m$ ; also

$T$  = time of maximum declination =  $t_0 - \frac{y}{2z}$

In case the change of declination can be represented by a straight line, we have

$D = d_0 + a(t - t_0)$  and the conditional equation will be of the simple form:  $0 = d_0 - D + a(t - t_0)$

where  $d_0$  = mean of all observed declinations and  $t_0$  = mean of corresponding times.

The principal uncertainty in the investigation thus arises partly from large observing or instrumental errors in the older observations made with ordinary compasses or with rude instruments generally, and partly, in case of modern observations, since the introduction of more refined instruments (the magnetometer with collimator magnet and theodolite), from change of local positions and from imperfect elimination of irregular variations from the normal direction of the magnet. In consequence of the extended use of iron above and below ground and the rapid growth of cities covering up older stations, it is difficult to select and preserve at such places a suitable locality for permanent use. Accurate investigations of the secular variation can only be made at regular magnetic observatories or in localities exempt from all disturbing influences.

In applying at present a periodic function for the representation of the secular variation,\* it should be understood that this *does not necessarily* imply that the phenomenon is a periodic one, or even has an invariable period of the length assigned, or that it must exhibit a second or repeated motions of like character to the first, or even that a first period will be completed without some minor change of law. The aim is simply to represent by a suitable and comprehensive formula the changes which are observed in the direction of the horizontal component of the magnetic force from year to year and during centuries, and to provide the means for the further study of the phenomenon with a view to ascertaining its probable cause, as well as for predicting, at least for a few years in advance, the probable direction of the needle, this information being required in the construction of our hydrographic charts, as well as by the navigator and the surveyor.

The analytical process is thus one of a tentative character and the formulæ are necessarily empirical. Employing a formula of interpolation capable of representing the phenomenon only as far as observed, it would manifestly be unsafe to extend the numerical results either way much beyond the limits of observation. The predictions are here given within proper and safe limits, and these should not be transcended unless the results are sustained by additional observations.

#### COLLECTION OF OBSERVED MAGNETIC DECLINATIONS SUITABLE FOR THE INVESTIGATION OF THE SECULAR VARIATION.

The material collected for this purpose has been arranged geographically in three groups for greater convenience of reference and of comparison of results. It approximates to an arrangement proceeding from stations of the greatest west declination (at present) to those of greatest east declination, and comprises the whole area of the United States as well as a few foreign locali-

\* If we suppose for the moment that the secular variation consists simply of a swing about a mean position, the deflecting force being a maximum at the times of elongation and zero for the epoch midway between, we may obtain some rough evaluation of the magnitude of the horizontal deflecting force when greatest. Thus, at Philadelphia the half-amplitude or the secular deflection either way from the normal equals nearly  $3^\circ.3$  and the last extreme deflection happened about 1802. At that time, then, the deflecting force corresponded to  $\frac{3.3}{57.3} = \frac{1}{17}$  nearly of the normal horizontal force acting in the plane of the meridian. This deflecting force is very much greater than the deflecting force which produces the daily solar variation, the latter being at most, at Philadelphia, for an average amplitude of  $4^\circ.0$ , equal to  $\frac{4.0}{3437.7} = \frac{1}{860}$  nearly of the same normal horizontal force.

ties, which were introduced for the special purpose of preparing the way for geographically extending and connecting the laws of the secular change.

Group I comprises stations mainly on the Atlantic coast of the United States and the region east of the Appalachian range.

In particular the stations of this eastern series extend from Newfoundland and Eastern Canada along our Atlantic coast as far south as Florida. Added to these are one station in France, one in the Bermuda Islands, and one in Brazil.

Group II includes stations mainly in the central part of the United States, between the Appalachian and Rocky Mountain systems.

In particular the stations of this central series cover the region south of Hudson Bay and within the United States, including the entire area drained by the Gulf of Mexico. Added to these are two stations in the West Indies and one in Central America.

Group III comprises mainly the Pacific coast stations, and includes the Rocky Mountain region.

In particular the stations are scattered from the Isthmus of Tehuantepec through the western coast States and Territories, including Alaska. To this group are added one station in Siberia and two in the Sandwich Islands.

Each group is treated separately; the record of observations is given first with such notes appended as seemed demanded; then follow the analytical formulæ expressing the secular change, next are given the comparisons between observed and computed values, and the statement of results is completed by decennial tabular values of the declination up to the year 1850, after that the computed values are given for every fifth year, ending with 1895. It is of course to be expected that through future accumulation of data the results may be made more comprehensive and reliable than can be done at present.

GROUP I.—*Series of magnetic stations mainly on the Atlantic coast and in the region east of the Appalachian range.*

The stations of this eastern series are irregularly distributed over the region between Newfoundland and Florida, with one station each in France, in the Bermudas, and Brazil.

Observations were collected and discussed for secular change of declination at the following places:

- |                                         |                                           |
|-----------------------------------------|-------------------------------------------|
| 1. Saint John's, Newfoundland.          | 23. Albany, N. Y.                         |
| 2. Charlottetown, Prince Edward Island. | 24. Oxford, N. Y.                         |
| 3. Halifax, Nova Scotia.                | 25. New York, N. Y.                       |
| 4. Quebec, Canada.                      | 26. Bethlehem, Pa.                        |
| 5. Montreal, Canada.                    | 27. Hatboro', Pa.                         |
| 6. Eastport, Me.                        | 28. Philadelphia, Pa.                     |
| 7. Portland, Me.                        | 29. Harrisburg, Pa.                       |
| 8. Burlington, Vt.                      | ... Tyrone, Pa.                           |
| 9. Hanover, N. H.                       | 30. Huntingdon, Pa.                       |
| 10. Chesterfield, N. H.                 | 31. Chambersburg, Pa.                     |
| 11. Rutland, Vt.                        | 32. Baltimore, Md.                        |
| 12. Portsmouth, N. H.                   | 33. Washington, D. C.                     |
| 13. Newburyport, Mass.                  | 34. Cape Henlopen, Del.                   |
| 14. Salem, Mass.                        | 35. Williamsburg, Va.                     |
| 15. Boston, Mass.                       | 36. Cape Henry, Va.                       |
| 16. Cambridge, Mass.                    | 37. New Berne, N. C.                      |
| 17. Provincetown, Cape Cod, Mass.       | 38. Charleston, S. C.                     |
| 18. Nantucket, Mass.                    | 39. Savannah, Ga.                         |
| 19. Providence, R. I.                   | 40. Milledgeville, Ga.                    |
| 20. Williamstown, Mass.                 | 41. Paris, France.                        |
| 21. Hartford, Conn.                     | 42. Saint George's Town, Bermuda Islands. |
| 22. New Haven, Conn.                    | 43. Rio de Janeiro, Brazil.               |

The first column of the record for any station contains the running number of the observed values made use of in the discussion; the second, the date of the observation; the third, the observed value; and the fourth, the name of the observer, the geographical position of the station, the reference to publication, and other pertinent remarks.

## GROUP I.—Collection of Magnetic Declinations observed at various places.

## 1.—SAINT JOHN'S, NEWFOUNDLAND.

 $\phi = 47^{\circ} 34' .4$        $\lambda = 52^{\circ} 41' .9$  W. of Gr.

(Government House.)

|    |                             | $^{\circ}$ / |    |                                                                                                                                                                                                                |
|----|-----------------------------|--------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1700. o.                    | 15           | W. | Edm. Halley's Tabula Nautica; Variationum Magneticarum index, etc., 1700. Greenwich astro'l observations, 1869. [Auxiliary value.—SCH.]                                                                        |
| 2  | 1787--                      | 16           |    | E. Walker's "Terrestrial and Cosmical Magnetism," Cambridge, 1866, plate 7, according to Hansteen. [Auxiliary value.—SCH.]                                                                                     |
| 3  | 1833--                      | 26 30        |    | P. Barlow's isogonic chart, in Phil. Trans. Roy. Soc., 1833, pt. I, p. 668.                                                                                                                                    |
| 4* | 1844, October.              | 29 36        |    | Capt. Bayfield, R. N.; in Phil. Trans. Roy. Soc., 1849, p. 211.                                                                                                                                                |
| 5* | 1857, July.                 | 31 21        |    | Capt. Dayman, R. N.; account of deep-sea soundings in the North Atlantic Ocean, 1858, p. 61.                                                                                                                   |
| 6* | 1862, September 11.         | 31 20        |    | } Capt. Orlebar, R. N.                                                                                                                                                                                         |
| 7* | 1863, September 22.         | 31 18        |    |                                                                                                                                                                                                                |
| 8* | 1864, June 3.               | 31 00        |    |                                                                                                                                                                                                                |
| 9* | 1866, April to October.     | 30 55        |    | Near Government House.                                                                                                                                                                                         |
|    | 1881, June 29.              | 30 26        |    | Lieut. C. P. Perkins, U. S. S. Alliance; in $\phi = 47^{\circ} 34'$ , $\lambda = 52^{\circ} 35'$ W. Naval Professional Papers No. 19, Washington, 1886.                                                        |
| 10 | 1881, September 26, 27, 28. | 30 37.3      | W. | Lieut. S. W. Very, N. S. N., Asst. Coast and Geod. Survey. In N. W. corner of grounds surrounding the Government House. [Mean value + $30^{\circ} .52$ for 1881.6; the weight 3 was given to this value.—SCH.] |

## 2.—CHARLOTTETOWN, PRINCE EDWARD ISLAND.

 $\phi = 46^{\circ} 14'$        $\lambda = 63^{\circ} 27'$  W. of Gr.

|   |                     | $^{\circ}$ / |    |                                                                                                                                                                                                                        |
|---|---------------------|--------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1833. o.            | 19 30        | W. | Peter Barlow's isogonic chart for 1833, Phil. Trans. Roy. Soc., 1833, pt. i, p. 668.                                                                                                                                   |
| 2 | 1842, June.         | 21 03        |    | Capt. Bayfield, R. N. Letter of Staff-Comdr. F. J. Evans of Jan. 5, 1866; see also Phil. Trans. Roy. Soc., 1849, p. 211.                                                                                               |
| 3 | 1857, May.          | 23 02        |    | } Capt. Orlebar, R. N. Reference as above.                                                                                                                                                                             |
| 4 | 1858, May 18.       | 22 54        |    |                                                                                                                                                                                                                        |
| 5 | 1859, May 20.       | 22 51        |    |                                                                                                                                                                                                                        |
| 6 | 1860, May 17.       | 22 50        |    |                                                                                                                                                                                                                        |
| 7 | 1861, May 14.       | 22 45        |    |                                                                                                                                                                                                                        |
| 8 | 1862, May 27.       | 23 19        |    | } Lieut. J. C. Rich, U. S. S. Alliance; in $\phi = 46^{\circ} 10'$ , $\lambda = 62^{\circ} 18'$ W: Naval Professional Papers No. 19, Washington, 1886.                                                                 |
|   | 1883, August 29.    | 24 02        |    |                                                                                                                                                                                                                        |
| 9 | 1833, September 22. | 24 19        | W. | Lieut. R. B. Peck, U. S. S. Swatara; in $\phi = 46^{\circ} 10'$ , $\lambda = 62^{\circ} 27'$ W. Reference as above. [Mean $24^{\circ} 10' .5$ W., reduction to town — $45'$ ; hence decl'n = $23^{\circ} 26'$ W.—SCH.] |

\* The information for the years marked by an asterisk was communicated to the office by Staff-Commander F. J. Evans, hydrographer to the British Admiralty.

*Collection of Magnetic Declinations, etc.—Continued.*

## 3.—HALIFAX, NOVA SCOTIA.

 $\phi = 44^{\circ} 39'.6$        $\lambda = 63^{\circ} 35'.3$  W. of Gr.

(Naval Yard Observatory.)

|     |                         |                    |                                                                                                                                                                                                                                                                                                                                     |
|-----|-------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | 1604-1612.              | $16\frac{1}{2}$ W. | According to Champlain's observations at Cape Breton, in Nova Scotia and New Brunswick. At Cape La Heve, the station nearest to Halifax, he observed $16^{\circ} 15'$ W., in $\phi = 44^{\circ} 11'$ , $\lambda = 64^{\circ} 15'$ W. Trans. Lit. and Hist. Soc. of Quebec, session 1864-'65, John Langton, president; Quebec, 1865. |
| 2   | 1700. 0.                | 13                 | Edm. Halley's Tabula Nautica; Variationum Magneticarum index, &c., 1700; Greenwich astro'l observations, 1869. [Auxiliary value.—SCH.]                                                                                                                                                                                              |
| 3*  | 1756--                  | 12 50              | From a MS. map by Charles Morris, asst. surveyor.                                                                                                                                                                                                                                                                                   |
| 4*  | 1775--                  | 13 35              | Des Barres' sailing directions.                                                                                                                                                                                                                                                                                                     |
| 5*  | 1798--                  | 16 30              | Plan of Halifax, published by Thomas Backhouse.                                                                                                                                                                                                                                                                                     |
| 6*  | 1818 (?).               | 17 28              | Remark-book of J. Napier, master R. N.; as given by Anthony Lockwood.                                                                                                                                                                                                                                                               |
| 7*  | 1821, June to November. | 17 36              | Observer as above; observation in June, $17^{\circ} 38'.2$ W.; in Nov., $17^{\circ} 33'.5$ W.                                                                                                                                                                                                                                       |
| 8   | 1833. 0.                | 17 30              | Peter Barlow's isogonic chart for 1833 in Phil. Trans. Roy. Soc., 1833, pt. i, p. 668.                                                                                                                                                                                                                                              |
| 9*  | 1852-53.                | 18 10              | Capt. Bayfield, magnetic survey.                                                                                                                                                                                                                                                                                                    |
| 10* | 1852-53.                | 18 51              | Remark-book by J. Hill, master R. N., viz, Aug., 1852, $18^{\circ} 46'$ W.; Sept., 1852, $19^{\circ} 21'$ W., and Aug., 1853, $18^{\circ} 25'$ W. [We adopt, for 1852.7, the mean value $18^{\circ} 46'$ W., and for 1853.2, the value $18^{\circ} 51'$ W.]                                                                         |
| 11* | 1860, July 22.          | 19 55              | Capt. Orlebar, R. N.                                                                                                                                                                                                                                                                                                                |
| 12* | 1866, April.            | 21 05.6            | Halifax Dock Yard, in $\phi = 44^{\circ} 40'$ , $\lambda = 63^{\circ} 25'$ W.; declination April 1, at 9 a. m., $20^{\circ} 55'.0$ W.; on April 3, at 3 p. m., $21^{\circ} 16'.3$ W.                                                                                                                                                |
| 13  | 1873, May 15.           | 21 35              | H. M. S. Challenger, at Drill ground, Dock Yard, in $\phi = 44^{\circ} 39'.8$ , $\lambda = 63^{\circ} 35'.2$ W. Report on the scientific results of the voyage of H. M. S. Challenger, etc. Narrative, Vol. II. London, 1882, pp. 26 and 46.                                                                                        |
| 14  | 1879, September 8, 10.  | 20 43.3 W.         | J. B. Baylor, United States Coast and Geodetic Survey, at southeast end of Dock Yard; in $\phi = 44^{\circ} 39'.5$ , $\lambda = 63^{\circ} 35'.0$ W. Coast and Geodetic Survey Report for 1881, Appendix No. 9.                                                                                                                     |

\* Observations marked by an asterisk were communicated to the Survey by Staff-Commander Fred. John Evans, R. N.; letters dated January 5, 1886, and April 26, 1887.

## 4.—QUEBEC, CANADA.

 $\phi = 46^{\circ} 48'.4$        $\lambda = 71^{\circ} 14'.5$  W. of Gr.

(Wolfe's Monument.)

|   |          |          |                                                                                                                                                                                                                                                            |
|---|----------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1642--   | $16$ W.  | Padre Bressani; Hansteen's Magnetismus der Erde, 1819; also Trans. of the Lit. and Hist. Society of Quebec, 1865.* [Hansteen's date, 1649, changed to 1642, according to President Langton's art. X of Trans. The weight 0.5 is given to this value.—SCH.] |
| 2 | 1686--   | 15 30    | De Hayes; Hansteen's Mag. der Erde, 1819.                                                                                                                                                                                                                  |
| 3 | 1700. 0. | 16       | Edm. Halley's isogonic chart for 1700, Greenwich observations for 1869.                                                                                                                                                                                    |
| 4 | 1785--   | 12 35 W. | Surveyor-General Holland; E. T. Fletcher in Trans. of the Lit. and Hist. Soc. of Quebec, 1865, art. ix.                                                                                                                                                    |

\* I am indebted to Mr. Marcus Baker, of the Computing Division, Coast and Geodetic Survey, for pointing out and procuring this volume for me.

## Collection of Magnetic Declinations, etc.—Continued.

## QUEBEC, CANADA—Continued.

|    |                    | ° /   |    |                                                                                                                         |
|----|--------------------|-------|----|-------------------------------------------------------------------------------------------------------------------------|
| 5  | 1789, June 30.     | 11 45 | W. | Louis Perrault, P. L. S.; reference as above.                                                                           |
| 6  | 1791, June 22.     | 13 00 |    | Pierre Beaupré, P. L. S.; reference as above.                                                                           |
| 7  | 1792, March, 24.   | 12 15 |    | J. B. Demers, P. L. S.                                                                                                  |
|    | 1792, May 9.       | 13 09 |    | A. Dezery, P. L. S.                                                                                                     |
|    | 1792, May 16.      | 12 00 |    | Ch. Turgeon, P. L. S.                                                                                                   |
|    | 1792, May 16.      | 12 15 |    | Fr. Legendre, P. L. S.                                                                                                  |
| 8  | 1793--             | 12 05 |    | Surveyor-General Holland                                                                                                |
|    | 1793, November 19. | 13 00 |    | J. C. Antill, P. L. S.                                                                                                  |
| 9  | 1805, April.       | 11 35 |    | Reg. A, folio 117, Dept. of Crown Lands; reference as above.                                                            |
| 10 | 1810--             | 11 00 |    | Becquerel's <i>Traité du Magnétisme</i> , Paris, 1846.                                                                  |
|    | 1810, June 5.      | 12 15 |    | Reg. A, folio 131; E. T. Fletcher, <i>Trans. Lit. and Hist. Soc. of Quebec</i> , 1865.<br>[Mean+11°.62 for 1810.5—SCH.] |
| 11 | 1811, June.        | 12 15 |    | Reg. A, folio 143; reference as above.                                                                                  |
| 12 | 1814--             | 11 50 |    | Kent, <i>Becquerel's Traité du Magnétisme</i> , Paris, 1846.                                                            |
| 13 | 1820, October 2.   | 12 30 |    | Bourdages, P. L. S.; E. T. Fletcher, <i>Trans. Lit. and Hist. Soc. of Quebec</i> , 1865.                                |
|    | 1820, November.    | 12 35 |    | Livingstone, P. L. S.; reference as above. [Mean+12°.54 for 1820.8—SCH.]                                                |
| 14 | 1821, August, 25.  | 12 15 |    | Jno. McNaughten, P. L. S.                                                                                               |
|    | 1821, September.   | 13 00 |    | A. Cattanach, P. L. S.                                                                                                  |
|    | 1821, September.   | 13 00 |    | W. Ware, P. L. S.                                                                                                       |
|    | 1821, November 28. | 13 20 |    | E. Tetu, P. L. S.                                                                                                       |
| 15 | 1822, January 21.  | 13 00 |    | Jos. Hamel, P. L. S.                                                                                                    |
|    | 1822, January 21.  | 13 00 |    | Ph. Verrault, P. L. S.                                                                                                  |
|    | 1822, April 26.    | 13 00 |    | P. J. Bureau, P. L. S.                                                                                                  |
|    | 1822, May.         | 13 00 |    | Reg. A, folio 162½                                                                                                      |
| 16 | 1823, March 26.    | 13 00 |    | N. Le François, P. L. S.                                                                                                |
|    | 1823, May 12.      | 13 00 |    | D. S. Ballantyne, P. L. S.                                                                                              |
|    | 1823, October, 3.  | 13 00 |    | Jos. Gamahe, P. L. S.                                                                                                   |
|    | 1823, October, 23. | 13 00 |    | A. Bochet, P. L. S.                                                                                                     |
|    | 1823, November 14. | 13 00 |    | L. Dorval, P. L. S.                                                                                                     |
| 17 | 1824, March 2.     | 12 40 |    | A. Cattanach, P. L. S.; reference as above.                                                                             |
| 18 | 1831--             | 13 38 |    | Captain Bayfield, <i>Becquerel's Traité du Magnétisme</i> , Paris, 1846.                                                |
|    | 1831, July 20.     | 13 10 |    | Thom. Carrol, P. L. S.                                                                                                  |
|    | 1831, autumn.      | 13 00 |    | Jos. Hamel, P. L. S.                                                                                                    |
|    | 1831, September 6. | 14 00 |    | H. Corey, P. L. S.                                                                                                      |
| 19 | 1831, December 10. | 13 12 |    | John Newman, P. L. S.                                                                                                   |
|    | 1832, May.         | 13 00 |    | Reg. B, fol. 36; reference as above.                                                                                    |
| 20 | 1833, May.         | 12 30 |    | Reg. B, fol. 43--                                                                                                       |
|    | 1833, July.        | 13 00 |    | Reg. B, fol. 43--                                                                                                       |
|    | 1834--             | 14 14 |    | Capt. Bayfield; <i>Trans. Roy. Soc.</i> , June, 1872; Gen. Sir Edw. Sabine, <i>Conts. to Terr. Mag.</i> , No. xiii.     |
| 21 | 1834, March 10.    | 13 00 |    | Reg. A, fol. 197--                                                                                                      |
|    | 1834--             | 13 00 |    | Reg. B, fol. 61--                                                                                                       |
|    | 1834, July.        | 13 00 |    | Reg. B, fol. 69--                                                                                                       |
| 22 | 1835, December.    | 13 10 | W. | Reg. B, fol. 85; reference as above.                                                                                    |

## Collection of Magnetic Declinations, etc.—Continued.

## QUEBEC, CANADA—Continued.

|    |                         |         |    |                                                                                                                                                                                                                                     |                                                     |
|----|-------------------------|---------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| 23 | 1838 and 1839.          | 13 00   | W. | Reg. B, fol. 66---                                                                                                                                                                                                                  | Reference as above. [Mean + 13°.37 for 1839.3—SCH.] |
|    | 1839, May.              | 13 30   |    | Reg. B, fol. 144---                                                                                                                                                                                                                 |                                                     |
|    | 1839--                  | 13 35   |    | Reg. B, fol. 154---                                                                                                                                                                                                                 |                                                     |
| 24 | 1840, May 20.           | 13 50   |    | R. M. Moore, P. L. S. -----                                                                                                                                                                                                         | Reference as above. [Mean + 13°.71 for 1840.5—SCH.] |
|    | 1840, September 14.     | 13 35   |    | Procès-Verbal, by Jos. Bouchette, D. S. G.                                                                                                                                                                                          |                                                     |
| 25 | 1842, December 7.       | 13 50   |    | Reg. B, fol. 281., Anse des Mères; reference as above--                                                                                                                                                                             | [Mean + 14°.02 for 1842.7—SCH.]                     |
|    | 1842--                  | 14 12   |    | Capt. J. H. Lefroy, R. E.; Phil. Trans. Roy. Soc., 1849, part II.                                                                                                                                                                   |                                                     |
| 26 | 1846--                  | 14 32   |    | Reg. B, fol. 318, La Canardière; E. T. Fletcher, Trans. Lit. and Hist. Soc. of Quebec, 1865.                                                                                                                                        |                                                     |
| 27 | 1847, September 17.     | 15 30   |    | Reg. B, fol. 316----                                                                                                                                                                                                                | Reference as above. [Mean + 14°.64 for 1847.7—SCH.] |
|    | 1847, September 20.     | 14 45   |    | Reg. B, fol. 262----                                                                                                                                                                                                                |                                                     |
|    | 1847, October, 13.      | 13 40   |    | Reg. B, fol. 269----                                                                                                                                                                                                                |                                                     |
| 28 | 1848, February.         | 15 15   |    | Reg. B, fol. 277-----                                                                                                                                                                                                               | Reference as above. [Mean + 14°.58 for 1848.5—SCH.] |
|    | 1848, June 28.          | 14 00   |    | Reg. B, fol. 299-----                                                                                                                                                                                                               |                                                     |
|    | 1848, October.          | 14 30   |    | N. Le François, P. L. S., Field-Book C, 50--                                                                                                                                                                                        |                                                     |
| 29 | 1849, March 8.          | 15 30   |    | Reg. B, fol. 316----                                                                                                                                                                                                                | Reference as above. [Mean + 15°.37 for 1849.4—SCH.] |
|    | 1849, July 8.           | 15 15   |    | Reg. C, fol. 5-----                                                                                                                                                                                                                 |                                                     |
| 30 | 1850, April.            | 15 15   |    | Reg. C, fol. 13; reference as above.                                                                                                                                                                                                |                                                     |
| 31 | 1851, autumn.           | 15 00   |    | Reg. C, fol. 33; reference as above.                                                                                                                                                                                                |                                                     |
| 32 | 1853, January 19.       | 15 30   |    | Reg. B, fol. 320; reference as before.                                                                                                                                                                                              |                                                     |
| 33 | 1858, October 8.        | 15 34   |    | Capt. Orlebar, R. N.; communicated by Capt. F. J. Evans, Hydrographic Dept., Admiralty, London.                                                                                                                                     |                                                     |
| 34 | 1859, July 19.          | 16 17   |    | C. A. Schott, Asst. Coast Survey; station near Wolfe's Monument. Coast Survey Report for 1859, p. 296, $\phi$ and $\lambda$ as in heading.                                                                                          |                                                     |
| 35 | 1860, October 12.       | 16 28   |    | Capt. Orlebar, R. N.; communicated by Capt. F. J. Evans, Admiralty, London. [This value received double weight.—SCH.]                                                                                                               |                                                     |
| 36 | 1865--                  | 16 40   |    | E. T. Fletcher, surveyor to Dept. of Crown Lands. [This value was given double weight.—SCH.]                                                                                                                                        |                                                     |
| 37 | 1879, September 16, 19. | 17 13.7 | W. | J. B. Baylor, U. S. Coast and Geodetic Survey, in $\phi = 46^{\circ} 48' .4$ , $\lambda = 71^{\circ} 14' .5$ W.; station of 1859, Coast and Geodetic Survey Report for 1881, App. No. 9. [This value was given double weight.—SCH.] |                                                     |

## 5.—MONTREAL, CANADA.

 $\phi = 45^{\circ} 30' .5$        $\lambda = 73^{\circ} 34' .6$  W. of Gr.

(College Observatory, McGill University.)

|   |                |       |    |                                                                                                                                                 |                                                                                    |
|---|----------------|-------|----|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 1 | 1749--         | 10 38 | W. | M. Gillion -----                                                                                                                                | V. Colvin, Sup't Adirondack Survey, N.Y., 7th Annual Report, Albany. 1880, p. 492. |
| 2 | 1785--         | 8 24  |    | Holland, Surv. Gen. of Canada.                                                                                                                  |                                                                                    |
| 3 | 1793, July 26. | 8 15  |    | Jer. McCarthey, Trans. Lit. and Hist. Soc. of Quebec, session of 1864-'65, new series; Quebec, 1865, p. 3.                                      |                                                                                    |
| 4 | 1814--         | 7 45  |    | Becquerel's Traité du Magnétisme, Paris, 1846.                                                                                                  |                                                                                    |
| 5 | 1834--         | 8 00  |    | Capt. Bayfield; Gen. Sir. Edw. Sabine's Conts. No. ix, Phil. Trans. Roy. Soc., 1849; in $\phi = 45^{\circ} 32'$ , $\lambda = 73^{\circ} 34'$ W. |                                                                                    |
| 6 | 1835--         | 9 50  | W. | Reference as for Nos. 1 and 2.                                                                                                                  |                                                                                    |

*Collection of Magnetic Declinations, etc.—Continued.*

## 5.—MONTREAL, CANADA—Continued.

|   |                     |                  |                                                                                                                                                                                        |
|---|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7 | 1842, August.       | ° /<br>8 57.6 W. | Capt. J. H. Lefroy, R. E. Coast Survey Report for 1855, p. 304. Gen. Sir J. H. Lefroy's Diary of Magnetic Survey, Canada, etc., London, 1883.                                          |
| 8 | 1859, July 20.      | 12 21            | C. A. Schott, Asst. Coast Survey; Coast and Geodetic Survey Report for 1881, App. No. 9. Grounds of McGill University in $\phi = 45^{\circ} 30' .5$ , $\lambda = 73^{\circ} 34' .6$ W. |
| 9 | 1879, September 25. | 13 40.5 W.       | J. B. Baylor, Coast and Geodetic Survey. Grounds of McGill University. Report for 1881, App. No. 9.                                                                                    |

## 6.—EASTPORT, ME.

 $\phi = 44^{\circ} 54' .4$        $\lambda = 66^{\circ} 59' .2$  W. of Gr.

(Fort Sullivan.)

|    |                              |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----|------------------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1604-1612.                   | ° /<br>17 32 W. | Champlain's observation at Douchet Island, St. Croix River. [Information received from asst. H. Mitchell, May 4, 1877.—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 2  | 1700.0.                      | 13              | Edm. Halley's isogonic chart, Tabula Nautica; Variationum Magneticarum index, etc., 1700. Greenwich astronomical observations, 1869. [Auxiliary value.—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 3  | 1775--                       | 12 40           | At Grand Manan Island; Des Barres, Atlantic Neptune, London, 1781.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 4  | 1797--                       | 12 19           | From a chart, at the mouth of St. Croix, in $\phi = 45^{\circ} 05'$ , $\lambda = 67^{\circ} 12'$ W. Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838. [Reduction to Eastport about $-5'$ —SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 5  | 1833.0.                      | 14 30           | Peter Barlow's isogonic chart for 1833; Phil. Trans. Roy. Soc., 1833.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|    | 1857, September 16-19.       | 15 21.1         | G. W. Dean, asst. Coast Survey; at Calais, in $\phi = 45^{\circ} 11' .1$ , $\lambda = 67^{\circ} 16' .8$ W. Coast Survey Report for 1858, p. 191. [Reduction to Eastport— $12'$ , not used.—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 6  | 1860, August to December.    | 17 57.1         | <div style="display: flex; align-items: center;"> <div style="flex: 1;"> G. B. Vose .....<br/> G. B. Vose and S. Walker .....<br/> S. Walker, R. H. Talcott, E. Goodfellow .....<br/> E. Goodfellow .....<br/> E. Goodfellow, A. T. Mosman, H. W. Richardson .....<br/> H. W. Richardson ..... </div> <div style="flex: 1; font-size: 2em; padding: 0 10px;">}</div> <div style="flex: 1;"> Coast Survey observers;<br/> at the Fort Sullivan<br/> Magnetic Observa-<br/> tory, Coast and Geo-<br/> detic Survey Report<br/> for 1881, App. 9. <math>\phi =</math><br/> <math>44^{\circ} 54' .4</math>, <math>\lambda = 66^{\circ} 59' .2</math><br/> W. </div> </div> |
| 7  | 1861, January to December.   | 17 59.2         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 8  | 1862, January to December.   | 18 00.6         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 9  | 1863, January to December.   | 18 02.3         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 10 | 1864, January to July inclu. | 18 03.7         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 11 | 1865, July 22-25.            | 18 06.1         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 12 | 1873, September 2, 3.        | 18 56.0         | Dr. T. C. Hilgard, observer for Coast Survey; at Fort Sullivan, in $\phi = 44^{\circ} 54' .3$ , $\lambda = 66^{\circ} 59' .3$ W. Reference as above.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 13 | 1879, August 27, 28.         | 19 07.8 W.      | J. B. Baylor, U. S. Coast and Geodetic Survey; at station of 1860. Reference as before.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## 7.—PORTLAND, ME.

 $\phi = 43^{\circ} 38' .8$        $\lambda = 70^{\circ} 16' .6$  W. of Gr.

(Bramhall Hill.)

|  |         |                 |                                                                                                                 |
|--|---------|-----------------|-----------------------------------------------------------------------------------------------------------------|
|  | 1700.0. | ° /<br>12 25 W. | Edm. Halley's isogonic chart, Tabula Nautica, etc.; Greenwich astronomical observations, 1869. [Not used.—SCH.] |
|--|---------|-----------------|-----------------------------------------------------------------------------------------------------------------|

*Collection of Magnetic Declinations, etc.—Continued.*

## 7.—PORTLAND, ME.—Continued.

|    |                              |               |                                                                                                                                                                                                                  |
|----|------------------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1763--                       | 7 45 W.       | Prof. John Winthrop; at Falmouth, in $\phi=43^{\circ} 39'$ , $\lambda=70^{\circ} 19'$ W. Sill. Jour., vol. xvi, 1829; see also Prof. E. Loomis' remarks on the Winthrop table, in Sill. Jour., vol. xxxiv, 1838. |
| 2  | 1775--<br>1833.0.            | 8 30<br>10 00 | J. F. W. Des Barres' Atlantic Neptune, London, 1781.<br>Peter Barlow's isogonic chart for 1833; Phil. Trans. Roy. Soc., 1833. [Not used.—SCH.]                                                                   |
| 3  | 1845, June 4.                | 11 28.3       | Dr. J. Locke, in $\phi=43^{\circ} 41'$ , $\lambda=70^{\circ} 20'$ W.; Smithsonian Contributions to Knowledge, vol. iii, 1852.                                                                                    |
| 4  | 1851, August 18, 20.         | 11 41.1       | J. E. Hilgard, asst. Coast Survey; at Bramhall Hill, in $\phi=43^{\circ} 38'.8$ , $\lambda=70^{\circ} 16'.6$ W.; Coast Survey Report for 1854, p. 143.                                                           |
| 5  | 1859, July 15.               | 12 20         | C. A. Schott, asst. Coast Survey; at Bramhall Hill; Coast Survey Report for 1859, p. 296.                                                                                                                        |
|    | 1863, July 6.                | 12 18.1       | C. A. Schott, asst. Coast Survey; at Mount Joy Observatory, in $\phi=43^{\circ} 39'.9$ , $\lambda=70^{\circ} 14'.9$ W.; Coast Survey Report for 1863, p. 204. [Not used.—SCH.]                                   |
| 6  | 1863, July 15.               | 12 28.2       | C. A. Schott, asst. Coast Survey; at Bramhall Hill, near station of 1859; Coast Survey Report for 1863, p. 204.                                                                                                  |
| 7  | 1864, August to December.    | 12 43.7       | } Prof. H. W. Richardson, observer for U. S. Coast Survey; at Bramhall Hill; monthly determinations on four days each; Coast and Geodetic Survey Report for 1881, App. No. 9.                                    |
| 8  | 1865, January to December.   | 12 42.3       |                                                                                                                                                                                                                  |
| 9  | 1866, January to March incl. | 12 42.9       |                                                                                                                                                                                                                  |
| 10 | 1873, September 8, 9, 11.    | 12 43.6 W.    | Dr. T. C. Hilgard, observer for U. S. Coast Survey; near Mount Joy Observatory; reference as above. [To refer to Bramhall station, add 10'.—SCH.]                                                                |

## 8.—BURLINGTON, VT.

 $\phi=44^{\circ} 28'.5$      $\lambda=73^{\circ} 12'.0$  W. of Gr.

(Coast Survey astronomical station.)

|    |                  |              |                                                                                                                                                                                     |
|----|------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1793--           | 7 38 W.      | Dr. Williams; in $\phi=44^{\circ} 28'$ , $\lambda=73^{\circ} 14'$ W.; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                                                 |
| 2  | 1805--           | 6 12         | J. Johnson, in Thompson's History of Vermont. From repeated comparisons, declination believed by him to be a minimum at this time. [Weight $\frac{1}{2}$ given to this value.—SCH.] |
| 3  | 1818--           | 7 30         | } Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838; in                                                                                                                  |
| 4  | 1822--           | 7 42         |                                                                                                                                                                                     |
| 5  | 1826--           | 7 36         | Prof. G. W. Benedict; in $\phi=44^{\circ} 27'$ , $\lambda=73^{\circ} 10'$ W.; Prof. E. Loomis' collection in Sill. Jour., vol. xxxix, 1840.                                         |
| 6  | 1830--           | 8 10         | } Prof. E. Loomis' collection, Sill. Jour., vol. xxxiv, 1838.                                                                                                                       |
| 7  | 1831--           | 8 15         |                                                                                                                                                                                     |
| 8  | 1832--           | 8 25         |                                                                                                                                                                                     |
| 9  | 1834--<br>1837-- | 8 50<br>9 45 |                                                                                                                                                                                     |
|    |                  |              | Prof. G. W. Benedict; Thompson's History of Vermont. [Perhaps a misprint for $8^{\circ} 45'$ ; not used.—SCH.]                                                                      |
| 10 | 1840--           | 9 42         | J. Johnson; Thompson's History of Vermont.                                                                                                                                          |
| 11 | 1845, June 26.   | 9 22 W.      | Dr. J. Locke; in $\phi=44^{\circ} 27'$ , $\lambda=73^{\circ} 10'$ W.; Smithsonian Contributions to Knowledge, vol. iii, 1852.                                                       |

## UNITED STATES COAST AND GEODETIC SURVEY.

*Collection of Magnetic Declinations, etc.—Continued.*

## 8.—BURLINGTON, VT.—Continued.

|    |                       |                  |                                                                                                                                                                                   |
|----|-----------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12 | 1855, August 28.      | ° /<br>9 57.1 W. | C. A. Schott, asst. Coast Survey; at encampment flag-staff near the lake shore, in $\phi=44^{\circ} 29'.3$ , $\lambda=73^{\circ} 13'.4$ W.; Coast Survey Report for 1855, p. 337. |
| 13 | 1873, October 14, 15. | 11 19.0 W.       | Dr. T. C. Hilgard, observer for U. S. Coast Survey; in $\phi=44^{\circ} 28'.2$ , $\lambda=73^{\circ} 12'.3$ ; Coast and Geodetic Survey Report for 1881, App. 9.                  |

## 9.—HANOVER, N. H.

 $\phi=43^{\circ} 42'.3$        $\lambda=72^{\circ} 17'.1$  W. of Gr.

(Dartmouth College Observatory.)

|   |                     |               |                                                                                                                                                                                               |
|---|---------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1765..              | ° /<br>7 0 W. | According to President Wheelock, in $\phi=43^{\circ} 41'$ , $\lambda=72^{\circ} 10'$ W.; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                                        |
| 2 | 1810..              | 4 15          | President Wheelock; reference as above.                                                                                                                                                       |
| 3 | 1839..              | 9 15          | Prof. C. A. Young, in $\phi=43^{\circ} 42'$ , $\lambda=72^{\circ} 10'$ W.; Prof. E. Loomis' collection in Sill. Jour., vol. xxxix, 1840.                                                      |
| 4 | 1873, October 4-11. | 10 49.6       | Dr. T. C. Hilgard, observer for U. S. Coast Survey; near observatory; Coast and Geodetic Survey Report for 1881, App. 9.                                                                      |
|   | 1879, October 6.    | 10 50.5       | J. B. Baylor, Coast and Geodetic Survey. This station was the same as that of 1873, a little north of observatory. [Not used.—SCH.]                                                           |
| 5 | 1879, October 7.    | 11 38.4 W.    | Same observer; at a station three-quarters of a mile west of Observatory Hill, in $\phi=43^{\circ} 42'.3$ , $\lambda=72^{\circ} 18'.0$ W.; Coast and Geodetic Survey Report for 1881, App. 9. |

## 10.—CHESTERFIELD, N. H.

 $\phi=42^{\circ} 53'.5$        $\lambda=72^{\circ} 24'$  W. of Gr.

|    |        |                |                                                                                                                                                             |
|----|--------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1812.. | ° /<br>6 26 W. | Nathan Wilde, observer; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838; position assigned $\phi=42^{\circ} 53'$ , $\lambda=72^{\circ} 20'$ W. |
| 2  | 1813.. | 6 25           |                                                                                                                                                             |
| 3  | 1814.. | 6 17           |                                                                                                                                                             |
| 4  | 1815.. | 6 07           |                                                                                                                                                             |
| 5  | 1816.. | 6 03           |                                                                                                                                                             |
| 6  | 1817.. | 6 02           |                                                                                                                                                             |
| 7  | 1818.. | 6 00           |                                                                                                                                                             |
| 8  | 1819.. | 6 03           |                                                                                                                                                             |
| 9  | 1820.. | 6 00           |                                                                                                                                                             |
| 10 | 1821.. | 6 07           |                                                                                                                                                             |
| 11 | 1822.. | 6 12           |                                                                                                                                                             |
| 12 | 1823.. | 6 30           |                                                                                                                                                             |
| 13 | 1824.. | 6 40           |                                                                                                                                                             |
| 14 | 1825.. | 6 35           |                                                                                                                                                             |
| 15 | 1826.. | 6 35           |                                                                                                                                                             |
| 16 | 1827.. | 6 45           |                                                                                                                                                             |
| 17 | 1828.. | 6.52           |                                                                                                                                                             |
| 18 | 1829.. | 7 00           |                                                                                                                                                             |
| 19 | 1830.. | 7 06 W.        |                                                                                                                                                             |

*Collection of Magnetic Declinations, etc.—Continued.*

## 10.—CHESTERFIELD, N. H.—Continued.

|    |                  | ° /        |                                                                                                                                                                   |
|----|------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 20 | 1831--           | 7 10 W.    | Nathan Wilde, observer; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838; position assigned, $\phi = 42^{\circ} 53'$ , $\lambda = 72^{\circ} 20' W.$  |
| 21 | 1832--           | 7 15       |                                                                                                                                                                   |
| 22 | 1833--           | 7 30       |                                                                                                                                                                   |
| 23 | 1834--           | 7 35       |                                                                                                                                                                   |
| 24 | 1835--           | 7 40       |                                                                                                                                                                   |
| 25 | 1836--           | 7 45       | A. C. Twining; reference as above.                                                                                                                                |
| 26 | 1837--           | 8 05       |                                                                                                                                                                   |
| 27 | 1874, October 4. | 10 26.6 W. |                                                                                                                                                                   |
|    |                  |            | Dr. T. C. Hilgard, observer for Coast Survey; in $\phi = 42^{\circ} 54'.0$ , $\lambda = 72^{\circ} 26'.0 W.$ ; Coast and Geodetic Survey Report for 1881, App. 9. |

## 11.—RUTLAND, VT.

 $\phi = 43^{\circ} 36'.5$        $\lambda = 72^{\circ} 55'.5 W. of Gr.$ 

(Post-office.)

|   |                       | ° /        |                                                                                                                                                                                |
|---|-----------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1789, April.          | 7 03 W.    | Dr. Williams; Sill. Jour., vol. xvi, 1829. [Weight, $\frac{1}{2}$ assigned.—SCH.]                                                                                              |
| 2 | 1810, May.            | 6 04       |                                                                                                                                                                                |
| 3 | 1811, September.      | 6 01       |                                                                                                                                                                                |
| 4 | 1859, July 21.        | 9 49       | C. A. Schott, asst. Coast Survey; near new post-office; Coast Survey Report for 1859, p. 296.                                                                                  |
| 5 | 1873, October 17, 18. | 10 40.2    | Dr. T. C. Hilgard, observer for U. S. Coast Survey; Coast and Geodetic Survey Report for 1881, App. 9.                                                                         |
| 6 | 1879, October 14, 15. | 11 09.0 W. | J. B. Baylor, Coast and Geodetic Survey; station of 1873, north and west of post-office, in $\phi = 43^{\circ} 36'.5$ , $\lambda = 72^{\circ} 55'.5 W.$ ; reference as before. |

## 12.—PORTSMOUTH, N. H.

 $\phi = 43^{\circ} 04'.3$        $\lambda = 70^{\circ} 42'.5 W. of Gr.$ 

(New Castle Light-house.)

|   |                               | ° /        |                                                                                                                                                                                                     |
|---|-------------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1771--                        | 7 46 W.    | Holland, at Kittery, Me., opposite Portsmouth, in $\phi = 43^{\circ} 06'$ , $\lambda = 70^{\circ} 45' W.$ ; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                           |
| • | 1771--                        | 7 48       | Holland, in $\phi = 43^{\circ} 05'$ , $\lambda = 70^{\circ} 45'$ ; reference as above. [Not used.—SCH.]                                                                                             |
| 2 | 1775--                        | 7 45       | J. F. W. Des Barres' Atlantic Neptune, London, 1781.                                                                                                                                                |
| 3 | 1833. 0.                      | 8 45       | Peter Barlow's isogonic chart for 1833; Phil. Trans. Roy. Soc., 1833.                                                                                                                               |
| 4 | 1844-45.                      | 9 47       | Major Graham; at Boiling Rock; Gen. Sir Edw. Sabine, in Phil. Trans. Roy. Soc., 1872; in $\phi = 43^{\circ} 05'$ , $\lambda = 70^{\circ} 45' W.$                                                    |
| 5 | 1850, August 28, September 2. | 10 30.2    | J. E. Hilgard, asst. Coast Survey; at Kittery Point, Me.; Coast Survey Report for 1854, p. 143.                                                                                                     |
| 6 | 1859, July 14.                | 11 15.0    | C. A. Schott, asst. Coast Survey; at Kittery Point, Me.; Coast Survey Report for 1859, p. 296.                                                                                                      |
| 7 | 1879, August 13, 14.          | 12 31.3 W. | J. B. Baylor, U. S. Coast and Geodetic Survey; station of 1850 and 1859, in $\phi = 43^{\circ} 04'.8$ , $\lambda = 70^{\circ} 43'.0 W. of Gr.$ ; Coast and Geodetic Survey Report for 1881, App. 9. |

## UNITED STATES COAST AND GEODETIC SURVEY.

*Collection of Magnetic Declinations, etc.—Continued.*

## 13.—NEWBURYPORT, MASS.

 $\phi = 42^{\circ} 48'.9$        $\lambda = 70^{\circ} 49'.2$  W. of Gr.

(Plum Island Light.)

|   |                        |            |                                                                                                                                                         |
|---|------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1775--                 | 6 45 W.    | J. F. Des Barres' Atlantic Neptune, London, 1781; north of Cape Ann, opposite Newburyport.                                                              |
| 2 | 1781--                 | 7 18       | Dr. Williams, in $\phi = 42^{\circ} 48'$ , $\lambda = 70^{\circ} 52'$ W. Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                  |
| 3 | 1833.o.                | 8 30       | Peter Barlow's isogonic chart for 1833. Phil. Trans. Roy. Soc. for 1833.                                                                                |
| 4 | 1850, September 18-20. | 10 05.6    | J. E. Hilgard, asst. Coast Survey; on Plum Island, in $\phi = 42^{\circ} 48'.0$ , $\lambda = 70^{\circ} 48'.8$ W. Coast Survey Report for 1854, p. 143. |
| 5 | 1859, July 13.         | 10 58.0 W. | C. A. Schott, asst. Coast Survey; same position as in 1850. Coast Survey Report for 1859, p. 296.                                                       |

## 14.—SALEM,\* MASS.

 $\phi = 42^{\circ} 31'.9$        $\lambda = 70^{\circ} 52'.5$  W. of Gr.

(Fort Lee.)

|   |                            |                      |                                                                                                                                                                                  |
|---|----------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1781, August.              | 7 02 W.              | President Willard, at Beverly, in $\phi = 42^{\circ} 33'$ , $\lambda = 70^{\circ} 54'$ W. Mean of seven observations. Sill. Jour., vol. xvi, 1829. [Reduction to Salem—8'.—SCH.] |
| 2 | 1805, November.            | 5 57                 | Dr. Bowditch, in Summer st., Salem; from 115 observations.                                                                                                                       |
| 3 | 1808, June.                | 5 20                 | Dr. Bowditch, one-eighth of a mile south of above place; from 112 observations.                                                                                                  |
| 4 | 1810, April.               | { 5 47.7<br>5 13.4 } | Dr. Bowditch, about one-fourth of a mile east of the place of 1805. [Mean $5^{\circ} 30'.6$ —SCH.]                                                                               |
|   | 1810, April, to 1811, May. | 6 22.6               |                                                                                                                                                                                  |
| 5 | 1833.o.                    | 8 30                 | Peter Barlow's isogonic chart for 1833; Phil. Trans. Roy. Soc., 1833.                                                                                                            |
| 6 | 1849, August 20.           | 10 14.5              | Prof. G. W. Keely, observer for U. S. Coast Survey; at Fort Lee. Coast Survey Report for 1854, p. 143.                                                                           |
| 7 | 1855, August 25.           | 10 49.7              | C. A. Schott, asst. Coast Survey; at Fort Lee. Coast Survey Report for 1855, p. 337.                                                                                             |
| 8 | 1877.5.                    | 11 30 W.             | I. K. Harris, communicated to Superintendent in a letter dated Lynn, Feb. 18, 1878.                                                                                              |

\*The locality is subject to local magnetic deflections; these disturbances have been traced to and over Cape Ann.

## 15.—BOSTON, MASS.

 $\phi = 42^{\circ} 21'.5$        $\lambda = 71^{\circ} 03'.9$  W. of Gr.

(State-house.)

|  |        |       |                                                                                                                                                                                                                                                                                                                                                                                  |
|--|--------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | 1700-- | 10 W. | Prof. J. Winthrop's table, Sill. Jour., vol. xvi, 1829; also Mem. Am. Acad., vol. ii, new series, Cambridge, 1846. [Prof. E. Loomis has pointed out the observed and interpolated values of the Winthrop table; only the former are used. The table was originally published in the "Boston Boy," July 2, 1764, for which information I am indebted to Mr. J. H. Trumbull.—SCH.] |
|--|--------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

*Collection of Magnetic Declinations, &c.—Continued.*

## 15.—BOSTON, MASS.—Continued.

|    |                                    |         |    |                                                                                                                                                                                                          |
|----|------------------------------------|---------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1700.0                             | 10      | W. | Edm. Halley's isogonic chart for epoch 1700; reproduced by photolithography in Greenwich astron'l obser's for 1869. [Winthrop's value is supposed to be taken from Halley.]                              |
| 2  | 1708--                             | 9       |    | Mathews, observer; Sill. Jour. for 1829, Dr. N. Bowditch. See also Encyclopædia Metropolitana, London, 1848.                                                                                             |
| 3  | 1741--                             | 7 30    |    | Mathews; Encyclo. Metrop., London, 1848.                                                                                                                                                                 |
| 4  | 1775-'76.                          | 7 40    |    | Des Barres' Atlantic Neptune, London, 1871.                                                                                                                                                              |
| 5  | 1782--                             | 7 00    |    | Dr. N. Bowditch; Sill. Jour. for 1829; also first volume of Mem. Am. Acad.                                                                                                                               |
| 6  | 1793--                             | 6 30    |    | Mem. Am. Acad., new series, Cambridge, 1846; mean of 1644 observations.                                                                                                                                  |
| 7  | 1807--                             | 6 05    |    | Communicated by W. Rotch; letter dated Fall River, Feb. 17, 1874.                                                                                                                                        |
| 8  | 1833.0                             | 8 00    |    | Peter Barlow's isogonic chart for 1833; Phil. Trans. Roy. Soc. for that year.                                                                                                                            |
| 9  | 1839--                             | 9 06    |    | W. C. Bond; at Dorchester, in $\phi=42^{\circ}19'$ , $\lambda=71^{\circ}04'$ W.; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1840.                                                           |
| 10 | 1846, September 6-8                | 9 31.4  |    | Lieut. T. J. Lee, asst. Coast Survey; at Dorchester Heights, South Boston, in $\phi=42^{\circ}20'.0$ , $\lambda=71^{\circ}02'.5$ ; Coast Survey Report for 1854, p. 143.                                 |
| 11 | 1855, August 24.                   | 10 13.7 |    | C. A. Schott, asst. Coast Survey, in South Boston; locality as above; Coast Survey Report for 1855, p. 337.                                                                                              |
| 12 | 1872, September 28, 30; October 1. | 11 15.2 |    | A. H. Scott, observer for U. S. Coast Survey; locality as above; Coast and Geodetic Survey Report for 1881, App. 9.                                                                                      |
| 13 | 1877.5.                            | 11 36   |    | At meridian line on Boston Common, from records at the City Hall, communicated by I. K. Harris, Feb. 18, 1878.                                                                                           |
|    | 1884, October 18                   | 11 31   | W. | Lt. C. C. Cornwell, U. S. S. Powhatan; at sea, in $\phi=42^{\circ}20'$ , $\lambda=70^{\circ}47'$ W.; Naval Prof. Papers No. 19, Washington, 1886. [Reduction to Boston harbor uncertain; not used.—SCH.] |

## 16.—CAMBRIDGE, MASS.

 $\phi=42^{\circ}22'.9$        $\lambda=71^{\circ}07'.7$  W. of Gr.

(Harvard College Observatory.)

|     |        |      |    |                                                                                                                                                                                                                                                                           |
|-----|--------|------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | 1708-- | 9    | W. | Brattle, observer; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838; also Mem. Am. Acad., vol. ii, new series, Cambridge, 1846.                                                                                                                               |
| 2   | 1742-- | 8    |    | Prof. J. Winthrop's table; Sill. Jour., vol. xvi, 1829; also Mem. Am. Acad., vol. ii, new series, Cambridge, 1846. [See remarks on the Winthrop table in connection with the Boston series.—SCH.]                                                                         |
| 3   | 1757-- | 7 20 |    | Prof. J. Winthrop; reference as above.                                                                                                                                                                                                                                    |
| 4   | 1761-- | 7 14 |    | Dr. Williams; Mem. Am. Acad., vol. ii, new series, Cam., 1846.                                                                                                                                                                                                            |
| 5   | 1763-- | 7 00 |    | Prof. J. Winthrop; Sill. Jour., vol. xvi, 1829.                                                                                                                                                                                                                           |
| 6   | 1780-- | 7 02 |    | Dr. Williams; Encyclopædia Metropolitana, London, 1848.                                                                                                                                                                                                                   |
| 7 { | 1782-- | 6 45 |    | Dr. Williams; reference as above; also Mem. Am. Acad., 1846, where declination $6^{\circ}46'$ W. is given. Prof. Sewall, mean of extremes $6^{\circ}21'$ and $7^{\circ}08'$ W.; Sill. Jour. for 1829. See also first vol. of Mem. Am. Acad. [Used $6^{\circ}.75$ W.—SCH.] |
|     | 1782-- | 6 44 |    |                                                                                                                                                                                                                                                                           |
| 8   | 1783-- | 6 52 |    | Dr. Williams; Mem. Am. Acad., 1846; also Encycl. Metrop., 1848.                                                                                                                                                                                                           |
| 9   | 1788-- | 6 38 |    | Dr. Williams; Mem. Am. Acad., 1846.                                                                                                                                                                                                                                       |
| 10  | 1810-- | 7 30 | W. | Prof. Farrar; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                                                                                                                                                                                               |

*Collection of Magnetic Declinations, &c.—Continued.*

## 16.—CAMBRIDGE, MASS.—Continued.

|      |                     |             |                                                                                                                                                                                             |
|------|---------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      | 1833. 0.            | 8 0 W.      | Peter Barlow's isogonic chart in Phil. Trans. Roy. Soc., 1833. [Not used.—SCH.]                                                                                                             |
| 11   | 1835..              | 8 51        | Prof. Farrar; Prof. E. Loomis' collection, Sill. Jour., vol. xxxiv, 1838.                                                                                                                   |
| 12   | 1837..              | 9 09        | Mem. Am. Acad., Cambridge, 1846.                                                                                                                                                            |
| 13   | 1840. 4.            | 9 18        | W. C. Bond, director Harvard College Observatory; Mem. Am. Acad., 1846.<br>In $\phi=42^{\circ} 22'.9$ , $\lambda=71^{\circ} 07'.7$ W.                                                       |
| 14   | 1842. 2.            | 9 34. 9     | Prof. Jos. Lovering; half-hourly observations during one year, Oct., 1841, to Oct., 1842; Mem. Am. Acad., vol. iv, 1850.                                                                    |
| 15   | 1844..              | 9 39        | W. C. Bond, director Harvard College Observatory; MS. communicated by Prof. J. Lovering, of Harvard College.                                                                                |
| 16   | 1845, June 2.       | 9 32        | Dr. John Locke, Smithsonian Contributions to Knowledge, vol. iii, 1852.                                                                                                                     |
| 17   | 1850, August 9.     | 9 30        | Lieut. J. C. Ives; at Harvard College Observatory; Coast Survey Report for 1856, p. 222.                                                                                                    |
| 18   | 1852..              | 10 08       | W. C. Bond, director Harvard College Observatory; communicated by Prof. J. Lovering in letter of May 29, 1855.                                                                              |
| 19 { | 1854..              | 10 39       | Observer and reference as before.                                                                                                                                                           |
|      | 1854, May 10.       | 9 46        | Lieut. J. C. Ives, at Har. Coll. Obs'y; Coast Survey Rep. for 1856, p. 222.<br>[The mean $+10^{\circ}.21$ is used.—SCH.]                                                                    |
| 20   | 1855, May 22, 23.   | 10 54. 6    | W. C. Bond, director Har. Coll. Obs'y; communicated by him in letter of Dec. 24, 1858.                                                                                                      |
| 21 { | 1856, May 16.       | 10 50. 3    | W. C. Bond; reference as above.                                                                                                                                                             |
|      | 1856, July 17.      | 10 06       | Karl Friesach; at Cambridge Obs'y; results corrected for diurnal variation; Berichte der Kais. Kön. Akademie der Wiss., Vienna, vol. 29, 1858.<br>[The mean $+10^{\circ}.47$ is used.—SCH.] |
| 22   | 1859, March.        | 10 48       | Lieut. W. P. Smith, U. S. E.; at Har. Coll. Obs'y; communicated by Capt. G. G. Meade, U. S. E.                                                                                              |
| 23   | 1866-'67-'68.       | 10 41       | Prof. Jos. Winlock, director Harvard College Observatory; from a large number of observations communicated by him in Nov., 1872. [Computed by me and reduced to mean epoch 1867.5—SCH.]     |
| 24   | 1879, August 7, 9.. | 11 46. 3 W. | J. B. Baylor, U. S. Coast and Geodetic Survey; in the grounds of the Har. Coll. Obs'y, $\phi=42^{\circ} 22'.8$ , $\lambda=71^{\circ} 07'.6$ W.                                              |

## 17.—PROVINCETOWN, CAPE COD, MASS.

$$\phi=42^{\circ} 03'.1 \quad \lambda=70^{\circ} 11'.3 \text{ W. of Gr.}$$

(Town Hall.)

|   |                |         |                                                                                                                                                                                                                                                  |
|---|----------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1609, July 28. | 6 0 W.  | Hudson, third voyage; vicinity of Cape Cod. } Prof. E. Loomis, in Sill.                                                                                                                                                                          |
|   | 1609, July 29. | 5 30    | Hudson; near Cape Cod, at sunset..... } Jour., vol. xxxix, 1840.                                                                                                                                                                                 |
|   |                |         | [These values are probably too small, considering that Champlain found $18^{\circ} 40'$ W. at Malle Barres, now Nauset Inlet, Cape Cod, between 1608 and 1612; but this last value errs probably in the opposite direction. Not used.—SCH.]      |
| 1 | 1609 (?).      | 12 0 W. | On a map from Dudley's Arcano del Mare, published at Florence in 1646, we have the magnetic declination $12^{\circ}$ W. for latitude $42^{\circ} 30'$ , longitude $69^{\circ}$ W. [This value may refer to the time of Hudson and Champlain, but |

*Collection of Magnetic Declinations, etc.—Continued.*

## 17.—PROVINCETOWN, CAPE COD, MASS.—Continued.

|   |                         | ° / W.     |                                                                                                                                                                                                                                             |
|---|-------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |                         |            | must be earlier than 1639, the year of Dudley's death; see Narrative and Crit. Hist. of Am., by Justin Winsor, vol. iii, 1884, p. 303. 12° W. is here adopted.—SCH.] The probable error of this value may be estimated as between 2 and 3°. |
| 2 | 1700. 0.                | 9 30       | Edm. Halley's Tabula Nautica; Variationum, etc. Greenwich Astro'l Observations for 1869.                                                                                                                                                    |
| 3 | 1776--                  | 6 30       | At Nantucket, from a chart. Prof. Loomis, in Sill. Jour., vol. xxxix, 1840. [The reduction to Cape Cod may be estimated at +45', hence referred value 7° 15' W.—SCH.]                                                                       |
| 4 | 1833. 0.                | 8 15       | Peter Barlow's isogonic chart for 1833; Phil. Trans. Roy. Soc., for 1833.                                                                                                                                                                   |
| 5 | 1835, September.        | 9 20       | Major J. D. Graham, U. S. Eng. at House Pt. Island, in $\phi=42^{\circ}03'$ , $\lambda=70^{\circ}04'$ W. Government survey of Cape Cod. Sill. Jour., vol. xxxix, 1840; also, Phil. Trans. Roy. Soc., 1849.                                  |
| 6 | 1860, September 14, 15. | 11 23.5 W. | C. A. Schott, assist. Coast Survey; near Town Hall, in $\phi=42^{\circ}03'.2$ , $\lambda=70^{\circ}11'.1$ W. Coast and Geodetic Survey Report for 1881, App. 9.                                                                             |

## 18.—NANTUCKET, MASS.

 $\phi=41^{\circ}17'.0$        $\lambda=70^{\circ}06'.0$  W. of Gr.

(Mitchell's observatory.)

|    |                           | ° / W.   |                                                                                                                                                                                                                      |
|----|---------------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1700. 0.                  | 8 15     | Edm. Halley's Tabula Nautica, etc. Greenwich Astro'l Observations for 1869.                                                                                                                                          |
| 2  | 1775--                    | 6 30     | J. F. Des Barres' Atlantic Neptune, London, 1781.                                                                                                                                                                    |
|    | 1776--                    | 6 30     | From a chart; Prof. E. Loomis' collection, in Sill. Jour., vol. xxxiv, 1838. [Probably of the same origin as preceding value. Not used.—SCH.]                                                                        |
| 3  | 1833. 0.                  | 7 30     | Peter Barlow's isogonic chart of 1833; Phil. Trans. Roy. Soc., of that year.                                                                                                                                         |
| 4  | 1834--                    | 8 27     | } Wm. Mitchell; Sill. Jour., vol. xlvi.                                                                                                                                                                              |
| 5  | 1838-'39.                 | 9 02.3   |                                                                                                                                                                                                                      |
| 6  | 1842, August & September. | 9 09     |                                                                                                                                                                                                                      |
| 7  | 1843, September.          | 9 10     |                                                                                                                                                                                                                      |
| 8  | 1846, July 30, 31.        | 9 14.0   | Lieut. T. J. Lee, U. S. E., assist. Coast Survey; near Mitchell's house; Coast Survey Report for 1854, p. 143.                                                                                                       |
| 9  | 1855, August 22.          | 9 58.3   | C. A. Schott, assist. Coast Survey; near Nantucket Harbor light, on beach, in $\phi=41^{\circ}17'.5$ , $\lambda=70^{\circ}06'.0$ W. Coast Survey Report for 1855, p. 337.                                            |
| 10 | 1867, May 28, 29, 30.     | 10 19.9  | C. O. Boutelle, assist. Coast Survey; at Nantucket Cliff, in $\phi=41^{\circ}17'.2$ , $\lambda=70^{\circ}06'.3$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                                               |
| 11 | 1879, July 31, August 2.  | 11 27.9  | J. B. Baylor, U. S. Coast and Geodetic Survey; at the Cliff station; reference as above.                                                                                                                             |
| 12 | 1883, June 10.            | 11 38 W. | Lieut. E. S. Prime, U. S. S. Yantic; at sea, in $\phi=41^{\circ}29'$ , $\lambda=70^{\circ}12'$ W. Naval Professional Papers No. 19, Washington, 1886. [Reduction to Nantucket about -12', hence Dec. = +11°.43—SCH.] |

*Collection of Magnetic Declinations, etc.—Continued.*

19.—PROVIDENCE, R. I.

 $\phi = 41^{\circ} 50'.2$        $\lambda = 71^{\circ} 23'.8$  W. of Gr.

(Brown University.)

|    |                         | ° /        |                                                                                                                                                                                                                                                                                                                                                                                                              |
|----|-------------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1717--                  | 9 36       | W. R. Jackson, on a map of Providence.                                                                                                                                                                                                                                                                                                                                                                       |
|    | 1720--                  | 9 28       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1725--                  | 9 14       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1730--                  | 8 54       | Sill. Jour., vol. xlv, 1843. [The declinations between 1717 and 1843, incl. as given by M. B. Lockwood, civil engineer, are not stated to be from actual observations or from recorded bearings, and I strongly suspect that the table of results here presented is like the Winthrop table, and that for Hatboro', Pa., made up in great part by interpolation. Values 1720 to 1765, incl., not used.—SCH.] |
|    | 1735--                  | 8 39       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1740--                  | 8 15       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1745--                  | 7 59       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1750--                  | 7 40       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1755--                  | 7 21       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1760--                  | 6 57       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1765--                  | 6 43       |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 2  | 1769--                  | 6 30       | Dr. B. West. Prof. E. Loomis, in Sill. Jour., vol. xxxiv, 1838.                                                                                                                                                                                                                                                                                                                                              |
|    | 1775--                  | 6 20       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1780--                  | 6 16       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1785--                  | 6 13       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1790--                  | 6 10       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1795--                  | 6 10       | [See remark above; values 1775 to 1810, incl., not used.—SCH.]                                                                                                                                                                                                                                                                                                                                               |
|    | 1800--                  | 6 15       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1805--                  | 6 19       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1810--                  | 6 24       |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 3  | 1815--                  | 6 30       | M. Brown, B. Lockwood, and G. Shelden.                                                                                                                                                                                                                                                                                                                                                                       |
| 4  | 1819--                  | 6 37       | [Probably observed by Lockwood.—SCH.]                                                                                                                                                                                                                                                                                                                                                                        |
|    | 1825--                  | 6 51       | [See note above; values not used.—SCH.]                                                                                                                                                                                                                                                                                                                                                                      |
|    | 1830--                  | 7 10       |                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1833.0.                 | 6 00       | Peter Barlow's isogonic chart; Phil. Trans. Roy. Soc., 1833. [Not used.—SCH.]                                                                                                                                                                                                                                                                                                                                |
| 5  | 1835--                  | 7 34       |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 6  | 1840--                  | 8 25       |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 7  | 1841--                  | 8 31       |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 8  | 1842--                  | 8 39       |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 9  | 1843--                  | 8 46       |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 10 | 1855, August 20.        | 9 31.5     | C. A. Schott, assist. Coast Survey, east of Brown University, in $\phi = 41^{\circ} 50'.2$ , $\lambda = 71^{\circ} 23'.7$ ; U. S. Coast Survey Report for 1881, App. 9.                                                                                                                                                                                                                                      |
| 11 | 1884, June 20.          | 11 07.7    | O. T. Sherman; Report Board of Managers Yale College Obs'y, 1884-'85; in $\phi = 41^{\circ} 50'$ , $\lambda = 71^{\circ} 24'$ W.                                                                                                                                                                                                                                                                             |
| 12 | 1885, April 11, 13, 14. | 11 09.6 W. | J. B. Baylor, U. S. Coast and Geodetic Survey; station east of Brown University, near that of 1855, in $\phi = 41^{\circ} 50'.2$ , $\lambda = 71^{\circ} 23'.7$ W. MS. in archives.                                                                                                                                                                                                                          |

## UNITED STATES COAST AND GEODETIC SURVEY.

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*Collection of Magnetic Declinations, etc.—Continued.*

## 20.—WILLIAMSTOWN, MASS.

 $\phi = 42^{\circ} 42'.8$        $\lambda = 73^{\circ} 13'.4$  W. of Gr.

(Astronomical Observatory.)

|   |                    |         |    |
|---|--------------------|---------|----|
| 1 | 1786..             | 0 /     |    |
|   |                    | 5 52    | W. |
| 2 | 1833..             | 6 15    |    |
| 3 | 1837..             | 7 45    |    |
| 4 | 1876, July 28, 29. | 10 30.8 |    |
| 5 | 1886, August 22.   | 10 21   | W. |

Dr. Williams; Prof. E. Loomis' collection, Sill. Jour., vol. xxxiv, 1838.  
 Prof. A. Hopkins; Prof. E. Loomis' collection, Sill. Jour., vol. xxxix, 1840.  
 Prof. A. Hopkins; reference as before.  
 F. E. Hilgard, at North Adams, about 4 miles east of Williamstown; in  $\phi = 42^{\circ} 42'$ ,  $\lambda = 73^{\circ} 08' W.$ ; National Academy series, Coast and Geodetic Survey Report for 1882, App. 14.  
 A. Walker and Prof. T. H. Safford; southern part of meridian line of Williamstown College, in  $\phi = 42^{\circ} 42'.8$ ,  $\lambda = 73^{\circ} 13'.4$  W.; letter of A. Walker, dated Sept. 25, 1886.

## 21.—HARTFORD, CONN.

 $\phi = 41^{\circ} 45'.9$        $\lambda = 72^{\circ} 40'.4$  W. of Gr.

(State House.)

|     |                        |        |    |
|-----|------------------------|--------|----|
| 1   | 1786..                 | 0 /    |    |
|     |                        | 5 25   | W. |
| 2   | 1810..                 | 4 46   |    |
| 3   | 1824..                 | 5 45   |    |
| 4 { | 1828..                 | 6 03   |    |
|     | 1829..                 | 6 03   |    |
| 5   | 1859, July 27.         | 7 17.0 |    |
| 6   | 1857, August 15, 17.   | 7 49.3 |    |
|     | 1875 (?).              | 8 58   |    |
| 7   | 1879, July 24, 25, 26. | 8 34.0 | W. |

Dr. Williams; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.  
 Asher Miller, at East Hartford, in  $\phi = 41^{\circ} 46'$ ,  $\lambda = 72^{\circ} 38' W.$ ; reference as above.  
 N. Goodwin; reference as before.  
 C. A. Schott, asst. Coast Survey, in City Park; Coast Survey Report for 1859, p. 296.  
 C. A. Schott, asst. Coast Survey, near the Athenæum, in  $\phi = 41^{\circ} 45'.9$ ,  $\lambda = 72^{\circ} 40'.4$  W.; Coast and Geodetic Survey Report for 1881, App. 9.  
 T. C. Ellis, civil engineer. Report Chief of Engineers, U. S. A. In  $\phi = 41^{\circ} 45'$ ,  $\lambda = 72^{\circ} 40' W.$  [Not used—SCH.]  
 J. B. Baylor, U. S. Coast and Geodetic Survey; station of 1859 in City Park, in  $\phi = 41^{\circ} 45'.9$ ,  $\lambda = 72^{\circ} 40'.5$  W.; Coast and Geodetic Survey Report for 1881, App. 9.

## 22.—NEW HAVEN, CONN.

 $\phi = 41^{\circ} 18'.5$        $\lambda = 72^{\circ} 55'.7$  W. of Gr.

(Yale College.)

|     |               |        |    |
|-----|---------------|--------|----|
| 1   | 1761..        | 0 /    |    |
|     |               | 5 47   | W. |
| 2   | 1775..        | 5 25   |    |
| 3   | 1780..        | 5 15   |    |
| 4   | 1811..        | 5 10   |    |
|     | 1818, August. | 5 45   |    |
|     | 1819..        | 4 35   |    |
| 5 { | 1819, May.    |        |    |
|     | 1820, April.  | 4 25.4 | W. |

President Stiles.....  
 Prof. Strong.....  
 President Stiles.....  
 Nathan Redfield.....  
 Hon. De Witt, Sill. Jour., vol. xvi, 1829. [Not used—SCH.]  
 Prof. Fisher, of Yale College; Prof. E. Loomis' collection, Sill. Jour., vol. xxxiv, 1838. [Not used—SCH.]  
 Prof. Fisher, from hourly observations; Sill. Jour., vol. xvi, 1829.

*Collection of Magnetic Declinations, etc.—Continued.*

22.—NEW HAVEN, CONN.—Continued.

|    |                                       |           |                                                                                                                                                                                                                                     |
|----|---------------------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6  | 1828..                                | 5 17 W.   | N. Goodwin; Prof. E. Loomis' collection, Sill. Jour., vol. xxxiv, 1838.                                                                                                                                                             |
| 7  | 1834, November.                       | } 5 40.6  | Prof. E. Loomis, from hourly observations; Sill. Jour., vol. xxx, 1836.                                                                                                                                                             |
|    | 1835, November.                       |           |                                                                                                                                                                                                                                     |
|    | 1835..                                |           |                                                                                                                                                                                                                                     |
| 8  | 1836..                                | 5 52      | Prof. E. Loomis' collection of 1838. [Not used—SCH.]                                                                                                                                                                                |
| 9  | 1837, November.                       | 5 55      | E. C. Herrick; Prof. E. Loomis' collection of 1838.                                                                                                                                                                                 |
| 10 | 1840..                                | 5 50      | E. C. Herrick; Sill. Jour., vol. xxxiv, 1838.                                                                                                                                                                                       |
| 11 | 1844, August 28.                      | 6 10      | E. C. Herrick; Prof. E. Loomis' collection, Sill. Jour., vol. xxxix, 1840.                                                                                                                                                          |
|    |                                       | 5 45.1    | Prof. J. Renwick, observer for U. S. Coast Survey at Yale College, in $\phi = 41^{\circ} 18'.5$ , $\lambda = 72^{\circ} 55'.7$ ; Coast and Geod. Survey Report for 1881, App. 9.                                                    |
| 12 | 1845, September 10.                   | 6 17.3    | Prof. J. Renwick, observer for U. S. Coast Survey at Pavilion Hotel, south of college, near the bay, in $\phi = 41^{\circ} 18'$ , $\lambda = 72^{\circ} 54'.6$ W. Reference as above.                                               |
|    | 1847, September 25, 28, October 1, 2. | 7 27.2    | R. H. Fauntleroy, asst. Coast Survey, at Fort Wooster, in $\phi = 41^{\circ} 16'.9$ , $\lambda = 72^{\circ} 53'.6$ W. Reference as above. [Local deflection; observation not used—SCH.]                                             |
|    | 1848, August 21–29.                   | 7 25.5    | J. S. Ruth, subasst. Coast Survey, at Fort Wooster, position and reference as before. [Not used—SCH.]                                                                                                                               |
| 13 | 1848, August 10, 12, 14.              | 6 37.9    | J. S. Ruth, subasst. Coast Survey, Pavilion Hotel, position as in 1845. Reference as before.                                                                                                                                        |
|    | 1848, August 30, September 1.         | 6 31.9    | J. S. Ruth, subasst. Coast Survey, at Oyster Point, in $\phi = 41^{\circ} 17'.0$ , $\lambda = 72^{\circ} 55'.7$ W., in meridian of Yale College. Coast and Geod. Survey Report for 1881, App. 9. [Used mean, $+6^{\circ}.58$ —SCH.] |
| 14 | 1855, August 17.                      | 7 02.7    | C. A. Schott, asst. Coast Survey at Oyster Point, near position of 1848, in $\phi = 41^{\circ} 16'.9$ , $\lambda = 72^{\circ} 55'.8$ W. Reference as above.                                                                         |
|    | 1871, March.                          | 7 22      | G. H. Mann, C. E., on College Green, survey of the harbor of New Haven by the U. S. Engineers; MS. communication. [Not used; local deflection suspected—SCH.]                                                                       |
| 15 | 1872..                                | 8 27.5    | R. M. Bache, asst. Coast Survey; topographic and hydrographic survey of New Haven Harbor and vicinity; from bearings of trigonometrical lines. Hydrographic chart No. 1170.                                                         |
| 16 | 1878, July 18.                        | 8 41.2    | Dr. T. E. Thorpe, in Prof. Silliman's garden, in $\phi = 41^{\circ} 18'.7$ , $\lambda = 72^{\circ} 55'.6$ W. Proceedings of Royal Society, No. 200, 1880.                                                                           |
| 17 | 1884, January to May.                 | 8 50.9    | O. T. Sherman, Yale College Observatory grounds, near Silliman's garden, in $\phi = 41^{\circ} 18'.7$ , $\lambda = 72^{\circ} 55'.6$ . Report to Board of Managers Yale College Obs'y 1884–85. [Mean, $+8^{\circ}.93$ —SCH.]        |
|    | 1884, June to December.               | 9 01.0    |                                                                                                                                                                                                                                     |
|    | 1884, July 22.                        | 8 46.2    |                                                                                                                                                                                                                                     |
| 18 | 1885, January to June.                | 9 00.3 W. | O. T. Sherman, Yale College Observatory grounds. Reference as above.                                                                                                                                                                |

*Collection of Magnetic Declinations, etc.—Continued.*

## 23.—ALBANY, N. Y.

 $\phi = 42^{\circ} 39'.2$        $\lambda = 73^{\circ} 45'.8$  W. of Gr.

(State Capitol.)

|    |                       | ° /       |                                                                                                                                                                               |
|----|-----------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1817, October.        | 5 44      | W. { S. De Witt, surveyor-general; in $\phi = 42^{\circ} 39'$ , $\lambda = 73^{\circ} 44'$ W. Sill. Jour., vol. xvi, 1829.                                                    |
| 2  | 1818, August 1.       | 5 45      |                                                                                                                                                                               |
| 3  | 1825, April 24.       | 6 00      |                                                                                                                                                                               |
| 4  | 1828, September 20.   | 6 14      |                                                                                                                                                                               |
|    | 1828, September 22.   | 6 16      |                                                                                                                                                                               |
| 5  | 1830, June 14.        | 6 18      | Geological Report, State of New York, and Sill. Jour., vol. xxxix, 1840.                                                                                                      |
|    | 1831, May 5.          | 6 25      |                                                                                                                                                                               |
| 6  | 1831, November 5.     | 6 32      |                                                                                                                                                                               |
| 7  | 1834, October 1.      | 6 40      | Regents' Report.                                                                                                                                                              |
| 8  | 1836, October 29.     | 6 47      | Regents' Report and Sill. Jour., vol. xxxiv, 1838.                                                                                                                            |
| 9  | 1847, November.       | 7 35      | Regents' Report.                                                                                                                                                              |
| 10 | 1855, August 31.      | 7 54.7    | C. A. Schott, assistant Coast Survey; at Greenbush, opposite Albany, in $\phi = 42^{\circ} 37'.5$ , $\lambda = 73^{\circ} 44'.3$ W. Coast Survey Report for 1855, p. 337.     |
| 11 | 1856, September 1.    | 8 39.2    | Karl Friesach, Berichte der Kais. Kön. Akad., Vienna, vol. 29, 1858. [When corrected for diurnal variations, $+8^{\circ} 35'$ —SCH.]                                          |
| 12 | 1858, May 12, 13, 14. | 8 17.0    | G. W. Dean, assist. Coast Survey, at Dudley Observatory, in $\phi = 42^{\circ} 39'.8$ , $\lambda = 73^{\circ} 45'.0$ . Coast and Geodetic Survey Report for 1881, Appendix 9. |
| 13 | 1879, October 21, 24. | 9 51.7 W. | J. B. Baylor, U. S. Coast and Geodetic Survey; in grounds of Dudley Observatory, station of 1858. Coast and Geod. Survey Report, 1881, Appendix 9.                            |

## 24.—OXFORD, CHENANGO COUNTY, N. Y.

 $\phi = 42^{\circ} 26'.5$        $\lambda = 75^{\circ} 40'.5$  W. of Gr.

|    |                                       | ° /       |                                                                                                                                                                                                                                          |
|----|---------------------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1792 to 1795.                         | 3         | W. E. B. McCall, surveyor; in a letter to the Superintendent of the Coast Survey, dated Dec. 22, 1858.                                                                                                                                   |
| 2  | 1817--                                | 3         | E. B. McCall; in $\phi = 42^{\circ} 26'.5$ , $\lambda = 75^{\circ} 42'$ W. Reference as above.                                                                                                                                           |
| 3  | 1828, July 7.                         | 4 30      | [Weight $\frac{1}{2}$ given to this value—SCH.]                                                                                                                                                                                          |
| 4  | 1834, October 9.                      | 3 52      | Regents' Report; in $\phi = 42^{\circ} 28'$ , $\lambda = 75^{\circ} 33'$ W.; also Prof. E. Loomis' collection, Sill. Jour., vol. xxxiv, 1838.                                                                                            |
| 5  | 1836, October 5.                      | 4 09      |                                                                                                                                                                                                                                          |
| 6  | 1837--                                | 4 30      | Regents' Report of 1839; also Sill. Jour., 1838.                                                                                                                                                                                         |
| 7  | 1838, July 6.                         | 4 30      | At Guilford; in $\phi = 42^{\circ} 24'$ , $\lambda = 75^{\circ} 26'$ W. Regents' Report for 1839; also Sill. Jour., 1838. [ $4^{\circ} 27'$ when reduced to Oxford—SCH.]                                                                 |
| 8  | 1849, November 27.                    | 5 11      |                                                                                                                                                                                                                                          |
| 9  | 1857, April 4.                        | 5 44      | E. B. McCall; letter to Supt. of Dec. 22, 1858.                                                                                                                                                                                          |
| 10 | 1858, February 4.                     | 5 47      |                                                                                                                                                                                                                                          |
| 11 | 1858, December.                       | 5 50      |                                                                                                                                                                                                                                          |
| 12 | 1873, December 1.                     | 6 52      | Erving Taintor, local surveyor.                                                                                                                                                                                                          |
| 13 | 1874, May 29, 30; June 2, 3, 4, 5, 6. | 6 55.7    | Dr. T. C. Hilgard, observer for U. S. Coast Survey; on hill about three-fourths of a mile north of railroad depot; in $\phi = 42^{\circ} 26'.5$ , $\lambda = 75^{\circ} 40'.5$ W. Coast and Geodetic Survey Report for 1881, Appendix 9. |
| 14 | 1885, September 23, 24, 25.           | 7 43.3 W. | J. B. Baylor, subasst. Coast and Geodetic Survey; near Taylor and Scott streets, in $\phi = 42^{\circ} 26'.5$ , $\lambda = 75^{\circ} 40'.5$ W. MS. in archives of the Survey.                                                           |

*Collection of Magnetic Declinations, etc.—Continued.*

25.—NEW YORK CITY AND VICINITY, N. Y.

 $\phi = 40^{\circ} 42'.7$        $\lambda = 74^{\circ} 00'.4$  W. of Gr.

(New York City Hall.)

|    |                              |      |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----|------------------------------|------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1609, September 1.           | 0 /  | W. | Hudson, on his third voyage, Sept. 8, found $8^{\circ}$ W. on the Jersey shore, a little below the mouth of the Hudson River. The day before he found not above $2^{\circ}$ W. A few miles up the Hudson he found, in 1609, Sept. 13, $13^{\circ}$ W. Prof. E. Loomis' collection in Sill. Jour., vol. xxxix, 1840; extract furnished by Prof. J. Sparks from 3d vol. of Purchas' Pilgrims. [The known local deflections about the Palisades render the last result of doubtful value, and the first does not appear to possess much probability; the best that may now be done is perhaps to adopt provisionally the value $8^{\circ} \pm 2^{\circ}$ —SCH.] |
|    | 1609, September 2.           | 2    |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|    | 1609, September 13.          | 8    |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 2  | 1684--                       | 13   |    | Philip Welles, surveyor-general. Report of the New York Commissioners on the Connecticut boundary, made to the New York legislature in April, 1857 (Sen. Doc. 165, p. 155). Information received from J. H. Trumbull, April, 1876.                                                                                                                                                                                                                                                                                                                                                                                                                           |
|    |                              | 8 45 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|    |                              | 9 00 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 3  | 1686--                       | 9 00 |    | Geo. Keith, at Sandy Hook; line run between E. and W. New Jersey; records of proprietors of New Jersey. Communicated by Prof. G. H. Cook, State geologist of N. J., Oct. 11, 1879.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 4  | 1691--                       | 8 45 |    | On Staten Island; Geological Survey of New York, 1858. E. Duxbury's patent.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5  | 1700. 0.                     | 8 20 |    | Edm. Halley's isogonic chart for epoch 1700, reproduced by photo-lithography in the Greenwich observations for 1869.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 6  | 1714--                       | 8 45 |    | John Beatty, deputy surveyor; on map of Livingston's manor, New York. Engraved in O'Callaghan's Doc. Hist. N. Y., vol. iii, 414. Received from J. H. Trumbull.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 7  | 1723--                       | 7 20 |    | G. Burnet; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|    | 1724--                       | 7 20 |    | Cadwalader Colden, one of the commissioners of the New York and Connecticut boundary in 1724. Report of commissioners of 1857. Received from J. H. Trumbull. [The two results are supposed to come from the same source—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 8  | 1750--                       | 6 22 |    | Alexander; Prof. E. Loomis' collection in Sill Jour., vol. xxxiv, 1838.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 9  | 1755--                       | 5 00 |    | Evans; reference as above.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|    | 1775. 0.                     | 7    |    | J. F. W. Des Barres' Atlantic Neptune, London, 1781; at Sandy Hook. [Not used—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 10 | 1789--                       | 4 20 |    | Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838; also Encyclo. Metrop., 1848.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 11 | 1824--                       | 4 40 |    | Blunt's map; Prof. E. Loomis' collection of 1838.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|    | 1833. 0.                     | 3    |    | Peter Barlow's isogonic chart. Phil. Trans. Roy. Soc., 1833. [Not used—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 12 | 1834--                       | 4 50 |    | Capt. Owen; Prof. E. Loomis' collection of 1838.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 13 | 1837--                       | 5 40 |    | Prof. J. Renwick, at Columbia College (near City Hall). Prof. E. Loomis' collection of 1838.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 14 | 1840, June 16 to July 11.    | 5 01 |    | Lieut. S. C. Rowan, U. S. N., observer for U. S. Coast Survey; at Howard, Staten Island, in $\phi = 40^{\circ} 37'.6$ , $\lambda = 74^{\circ} 05'.4$ ; Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|    | 1840, July 18 to October 16. | 5 53 | W. | Lieut. S. C. Rowan, U. S. N., observer for U. S. Coast Survey; at Bergen Neck, in $\phi = 40^{\circ} 45'.8$ , $\lambda = 74^{\circ} 02'.6$ W. Reference as before. [Mean, $+5^{\circ}.45$ for 1840. 6—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

*Collection of Magnetic Declinations. etc.—Continued.*

25.—NEW YORK AND VICINITY, N. Y.—Continued.

|                     |                         |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
|---------------------|-------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------------|--------------------------------------------------------------------------|-----------------|---------------------|-----------------|---------------------|---------------------|---------------------|--------------------|---------------------|
| 15                  | 1841..                  | 6 06 W.                                                                  | Douglass' map of New Jersey; Coast Survey archives.                                                                                                                                                                                                                                                                                                                                                                                                              |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| 16                  | 1842, September.        | 5 32.5                                                                   | Coast Survey observer at Sandy Hook, N. J., in $\phi=40^{\circ} 27'.7$ , $\lambda=74^{\circ} 00'.2$ W.; Coast and Geod'c Survey Report for 1881, App. 9. [Probable reduction to New York + 22'—SCH.]                                                                                                                                                                                                                                                             |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
|                     | 1844, January.          | 5 51.1                                                                   | Lieuts. G. M. Bache, and J. Hall, U. S. N., observers for U. S. Coast Survey; at Sandy Hook; reference, position, and reduction as before. [Not used—SCH.]                                                                                                                                                                                                                                                                                                       |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
|                     | 1844, August 20, 22.    | 5 51.0                                                                   | Prof. J. Renwick, observer for U. S. Coast Survey; at Sandy Hook, N. J.; reference, position, and reduction as before. [Not used—SCH.]                                                                                                                                                                                                                                                                                                                           |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| 17                  | 1844, August 24.        | 6 13.1                                                                   | Prof. J. Renwick, observer for U. S. Coast Survey; at Columbia College (old position), in $\phi=40^{\circ} 42'.6$ , $\lambda=74^{\circ} 00'.5$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                                                                                                            |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| 18                  | 1845, September 4.      | 6 25.3                                                                   | Prof. J. Renwick, observer for U. S. Coast Survey; reference and position as before.                                                                                                                                                                                                                                                                                                                                                                             |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
|                     | 1846, April 30.         | 5 09.7                                                                   | Dr. John Locke, observer for U. S. Coast Survey; at Bloomingdale Asylum, Manhattanville, in $\phi=40^{\circ} 50'.3$ , $\lambda=73^{\circ} 56'.7$ W.; Coast and Geod'c Survey Report for 1881, App. 9.                                                                                                                                                                                                                                                            |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
|                     | 1846, May 4.            | 5 54.7                                                                   | Dr. John Locke, observer for U. S. Coast Survey; at Mt. Prospect (formerly Flatbush), Brooklyn, in $\phi=40^{\circ} 40'.3$ , $\lambda=73^{\circ} 58'.0$ . Reference as before. Other observations at this place are given in the Regents' Report of the University of the State of New York, viz:                                                                                                                                                                |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| 19                  |                         |                                                                          | <table><tr><td>Oct. 1834, 4 25 W.</td><td>Dec. 22, 1840, 5 00 W.</td><td rowspan="5">Assigned position<br/><math>\phi=40^{\circ} 37'</math>, <math>\lambda=73^{\circ} 58'</math> W.</td></tr><tr><td>Oct. 1835, 4 45</td><td>Dec. 30, 1841, 5 12</td></tr><tr><td>Oct. 1837, 4 45</td><td>Dec. 30, 1842, 5 10</td></tr><tr><td>Dec. 18, 1838, 4 45</td><td>Dec. 20, 1847, 5 30</td></tr><tr><td>Jan. 4, 1840, 4 55</td><td>Oct. 26, 1848, 5 15</td></tr></table> | Oct. 1834, 4 25 W. | Dec. 22, 1840, 5 00 W. | Assigned position<br>$\phi=40^{\circ} 37'$ , $\lambda=73^{\circ} 58'$ W. | Oct. 1835, 4 45 | Dec. 30, 1841, 5 12 | Oct. 1837, 4 45 | Dec. 30, 1842, 5 10 | Dec. 18, 1838, 4 45 | Dec. 20, 1847, 5 30 | Jan. 4, 1840, 4 55 | Oct. 26, 1848, 5 15 |
| Oct. 1834, 4 25 W.  | Dec. 22, 1840, 5 00 W.  | Assigned position<br>$\phi=40^{\circ} 37'$ , $\lambda=73^{\circ} 58'$ W. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| Oct. 1835, 4 45     | Dec. 30, 1841, 5 12     |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| Oct. 1837, 4 45     | Dec. 30, 1842, 5 10     |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| Dec. 18, 1838, 4 45 | Dec. 20, 1847, 5 30     |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| Jan. 4, 1840, 4 55  | Oct. 26, 1848, 5 15     |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
|                     | 1846, May 7.            | 5 37.4                                                                   | Dr. John Locke, observer for U. S. Coast Survey; at Cole, Staten Island, in $\phi=40^{\circ} 31'.9$ , $\lambda=74^{\circ} 14'.1$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                                                                                                                          |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
|                     | 1846, May 14.           | 5 35.1                                                                   | Dr. John Locke, observer for U. S. Coast Survey; at Newark, in $\phi=40^{\circ} 44'.8$ , $\lambda=74^{\circ} 10'.0$ W.; Coast and Geodetic Report for 1881, App. 9. [Mean value, + 5.57 for 1846.3—SCH.]                                                                                                                                                                                                                                                         |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| 20                  | 1847, October 16–20.    | 5 41.0                                                                   | R. H. Fauntleroy, assistant Coast Survey; at Legget, $\phi=40^{\circ} 48'.9$ , $\lambda=73^{\circ} 53'.5$ W. Reference as above.                                                                                                                                                                                                                                                                                                                                 |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
|                     | 1855, August 7.         | 6 39.6                                                                   | C. A. Schott, assist. Coast Survey; at Governor's Island, in $\phi=40^{\circ} 41'.5$ , $\lambda=74^{\circ} 01'.1$ W.; Coast and Geod'c Survey Report for 1881, App. 9.                                                                                                                                                                                                                                                                                           |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| 21                  | 1855, August 8.         | 7 02.1                                                                   | Observer and reference as above; At Bedloe's (Liberty) Island, in $\phi=40^{\circ} 41'.4$ , $\lambda=74^{\circ} 02'.7$ .                                                                                                                                                                                                                                                                                                                                         |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
|                     | 1855, August 11.        | 6 28.0                                                                   | Observer and reference as before; at receiving reservoir (now in Central Park), in $\phi=40^{\circ} 46'.7$ , $\lambda=73^{\circ} 58'.2$ W. [Mean used, + 6° 43'.2—SCH.]                                                                                                                                                                                                                                                                                          |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
|                     | 1855, August 14.        | 6 11.2                                                                   | Observer and reference as before; at Sandy Hook, N. J. Position as in 1842 and 1844. [Not used—SCH.]                                                                                                                                                                                                                                                                                                                                                             |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |
| 22                  | 1860, September 21, 22. | 6 44 W.                                                                  | C. A. Schott asst. Coast Survey; at Mt. Prospect (now Brooklyn new water works), in $\phi=40^{\circ} 40'.3$ , $\lambda=70^{\circ} 58'.0$ W.; Coast and Geod'c Survey Report for 1881, App. 9.                                                                                                                                                                                                                                                                    |                    |                        |                                                                          |                 |                     |                 |                     |                     |                     |                    |                     |

*Collection of Magnetic Declinations, etc.—Continued.*

## 25.—NEW YORK AND VICINITY, N. Y.—Continued.

|    |                                     |           |                                                                                                                                                                                                                  |
|----|-------------------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | 1872, October 31, November 1 and 2. | 8 45.8 W. | A. H. Scott, U. S. Coast Survey; at Central Park, west of mall, in $\phi=40^{\circ} 46'.2$ , $\lambda=73^{\circ} 58'.2$ W.; reference as above. [Not used; local deflection—SCH.]                                |
| 23 | 1873, November 5, 6, 7, 9.          | 7 09.0    | Dr. T. C. Hilgard, observer for U. S. Coast Survey; at Sandy Hook, N. J. Station near that of 1842, '44, '55, $\phi=40^{\circ} 27'.7$ , $\lambda=74^{\circ} 00'.2$ W. [Reduction to New York + 20'—SCH.]         |
| 24 | 1874, August.                       | 7 23      | Report of Chief of Engineers, U. S. A., for 1875; Chart of Way Reef, Hell Gate.                                                                                                                                  |
| 25 | 1879, July 17, 18.                  | 7 32.0    | J. B. Baylor, U. S. Coast and Geod'c Survey; at Sandy Hook, N. J.; station of 1873. [Reduction to New York + 20'—SCH.]                                                                                           |
|    | 1883, August 24.                    | 7 16      | Lieut. R. B. Beck, U. S. S. Swatara, in $\phi=40^{\circ} 29'$ , $\lambda=73^{\circ} 51'$ W.                                                                                                                      |
|    | 1884, May 1.                        | 7 00      | Lieut. U. Seabee, G. R. S. Thetis, in $\phi=40^{\circ} 26'$ , $\lambda=73^{\circ} 51'$ W.                                                                                                                        |
|    | 1884, July 17.                      | 7 34      | Lieut. R. B. Beck, U. S. S. Swatara, in $\phi=40^{\circ} 30'$ , $\lambda=73^{\circ} 50'$ W.                                                                                                                      |
|    |                                     |           | [Reduction to Sandy Hook, for values of 1883 and 1884, about —9'; not used—SCH.]                                                                                                                                 |
| 26 | 1885, September 30, October 1, 4.   | 7 52.8    | J. B. Baylor, subasst. Coast and Geod'c Survey; at Sandy Hook, N. J., station of 1879. MS. in Coast and Geod'c Survey archives. [Reduction to New York about + 20'—SCH.]                                         |
|    | 1885, October 16, 17, 18.           | 8 59.7 W. | J. B. Baylor, subasst. Coast and Geod'c Survey; in Riverside Park, N. Y., in $\phi=40^{\circ} 49'$ , $\lambda=73^{\circ} 57'.6$ W. MS. in archives of the Survey. [Not used on account of local deflection—SCH.] |

## 26.—BETHLEHEM, NORTHAMPTON COUNTY, PA.

 $\phi=40^{\circ} 36'.4$        $\lambda=75^{\circ} 23'.0$  W. of Gr.

(Sayre Observatory, Lehigh University, South Bethlehem.)

|    |                |         |                                                                                                                                                                                                                                         |
|----|----------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1757--         | 6 30 W. | R. W. Walker,* from bearings of old lines. [The weight one-half is given to this value—SCH.]                                                                                                                                            |
| 2  | 1784--         | 2 53    | Reference as above.*                                                                                                                                                                                                                    |
| 3  | 1799--         | 1 52    | Reference as above.* [The weight one-half is given to this value—SCH.]                                                                                                                                                                  |
| 4  | 1841, July 23. | 3 26    | Prof. A. D. Bache, at Easton, $3^{\circ} 38'.0$ W., in $\phi=40^{\circ} 42'$ , $\lambda=75^{\circ} 15'$ W.; Coast Survey Report for 1862, App. 19. [Reduction to Bethlehem, by isogonic map in Coast Survey Report for 1862, —12'—SCH.] |
| 5  | 1851--         | 3 50    | R. W. Walker,* from bearings of old lines.                                                                                                                                                                                              |
| 6  | 1874, June 20. | 5 19.5  | Dr. T. C. Hilgard, near Lehigh University; in $\phi=40^{\circ} 37'.0$ , $\lambda=75^{\circ} 22'.9$ W.; Coast and Geodetic Survey Report for 1881, App. 9. [Position corrected—SCH.]                                                     |
| 7  | 1878. 2.       | 5 37    | R. W. Walker,* from bearings of old lines.                                                                                                                                                                                              |
| 8  | 1881. 2.       | 5 52    | Prof. C. L. Doolittle, Lehigh University.*                                                                                                                                                                                              |
| 9  | 1882. 7.       | 6 05    | R. W. Walker,* deduced from 80 observations made by students.                                                                                                                                                                           |
| 10 | 1884. 0.       | 6 06 W. | R. W. Walker.*                                                                                                                                                                                                                          |

\* This result was given by Mr. R. W. Walker, and communicated to me by Prof. M. Merriman, of Lehigh University, letter of June 7, 1884.—SCH.

*Collection of Magnetic Declinations, etc.—Continued.*

27.—HATBOROUGH, MONTGOMERY COUNTY, PA.

 $\phi = 40^{\circ} 12'$        $\lambda = 75^{\circ} 07'$  W. of Gr.

|    |        | ° /  |    |
|----|--------|------|----|
| 1  | 1680-- | 8 28 | W. |
| 2  | 1690-- | 8 15 |    |
| 3  | 1700-- | 7 55 |    |
| 4  | 1710-- | 7 28 |    |
| 5  | 1720-- | 7 00 |    |
| 6  | 1730-- | 6 25 |    |
| 7  | 1740-- | 5 35 |    |
| 8  | 1750-- | 4 55 |    |
| 9  | 1760-- | 4 00 |    |
| 10 | 1770-- | 2 55 |    |
| 11 | 1780-- | 2 05 |    |
| 12 | 1790-- | 1 50 |    |
| 13 | 1800-- | 1 55 |    |
| 14 | 1810-- | 2 00 |    |
| 15 | 1820-- | 2 27 |    |
| 16 | 1830-- | 3 00 |    |
| 17 | 1840-- | 3 50 |    |
| 18 | 1850-- | 4 25 | W. |

Table communicated to the Supt. of the Coast Survey by Mr. E. W. Beans, letter dated Hatboro', March 1, 1852. Coast Survey Report for 1855, p. 312. [It cannot be supposed that this table presents results of direct observation, but likely is the result of some process of interpolation, probably a graphical one. Mr. Beans expressed his entire confidence in the accuracy of the data collected, and I do not doubt that the table is made up from reliable observations of numerous bearings of old (and new) lines. It should also be remembered that at the time this table was communicated our knowledge of the secular variation was very imperfect, and that it was subsequently found to be in good accord with our researches. It is to be regretted that in consequence of Mr. Beans' demise nothing further could be learned of the series—SCH.]

28.—PHILADELPHIA, PA.

 $\phi = 39^{\circ} 56'.9$        $\lambda = 75^{\circ} 09'.0$  W. of Gr.

(State House.)

|     |                            | ° /    |    |
|-----|----------------------------|--------|----|
| 1   | 1701--                     | 8 30   | W. |
| 2   | 1710--                     | 8 30   |    |
| 3   | 1750--                     | 5 45   |    |
| 4 { | 1793--                     | 1 30   |    |
|     | 1793--                     | 1 30   |    |
| 5   | 1802--                     | 1 30   |    |
| 6 { | 1804--                     | 2 00   |    |
|     | 1804--                     | 2 10   |    |
| 7 { | 1813--                     | 2 25   |    |
|     | 1813--                     | 2 27   |    |
| 8   | 1837--                     | 3 52   |    |
| 9   | 1840, June.                | 3 37   |    |
| 10  | 1841, July 20, November 1. | 3 53.7 | W. |

Observed by Mr. Scull, according to G. Gillet, Sill. Jour., vol. xxiii, 1833.  
Th. Whitney; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.  
Kalm's Travels; reference as above.  
Th. Whitney; reference as above.  
Mr. Brooks; Sill. Jour., vol. xxiii, 1833.  
Mr. Howell; reference as above.  
By several men of science; reference as before.  
Th. Whitney; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.  
D. McClure; reference as before.  
Th. Whitney; Sill. Jour., vol. xxiii, 1833.  
W. R. Johnson; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.  
Dr. A. D. Bache, at Girard College Observatory; in  $\phi = 39^{\circ} 58'.3$ ,  $\lambda = 75^{\circ} 10'.3$  W. Annual change =  $4'.4$  from differential observations between June, 1840, and Dec., 1845; see Coast Survey Reports for 1859, p. 285, and for 1860, p. 311. [Subtracting  $5'.3$  from the observed value of 1841 (see further on), we have for June, 1840, the value  $+ 3^{\circ} 48'$ , and subtracting  $26'$  from the observed value of 1846 (see further on), we have  $+ 3^{\circ} 26'$ ; the mean, or  $+ 3^{\circ} 37'$ , is set down for June, 1840—SCH.]  
Dr. A. D. Bache, at Girard College Observatory; Coast Survey Report for 1862; magnetic survey of Pennsylvania, p. 213.

*Collection of Magnetic Declinations, etc.—Continued.*

## 28.—PHILADELPHIA, PA.—Continued.

|    |                            |           |                                                                                                                                                                                                                                                             |
|----|----------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11 | 1846, May 23.              | 3 51.1 W. | Dr. John Locke, Girard College Magnetic Obs'y; Coast Survey Report for 1854, p. 144.                                                                                                                                                                        |
| 12 | 1855, September 5.         | 4 31.7    | C. A. Schott, assist. Coast Survey; grounds east of main building of Girard College, in $\phi = 39^{\circ} 58'.4$ , $\lambda = 75^{\circ} 10'.2$ W.; Coast Survey Report for 1855, p. 337.                                                                  |
| 13 | 1862, August 15, 16.       | 5 00.0    | C. A. Schott, assist. Coast Survey; at site of old magnetic observatory, Girard College; in $\phi = 39^{\circ} 58'.4$ , $\lambda = 75^{\circ} 10'.2$ W.; Coast Survey Report for 1862, p. 212.                                                              |
| 14 | 1872, October, 19, 20, 21. | 5 27.8    | A. H. Scott, U. S. Coast Survey; at site of old magnetic observatory, Girard College; Coast and Geod'c Survey Report for 1881, App. 9.                                                                                                                      |
| 15 | 1877, October 2, 3, 5, 6.  | 6 02.2    | J. B. Baylor, U. S. Coast Survey; SW. of main building of Girard College, in $\phi = 39^{\circ} 58'.3$ , $\lambda = 75^{\circ} 10'.3$ W.; Coast and Geodetic Survey Report for 1881, App. 9. [Weight assigned $1\frac{1}{2}$ —SCH.]                         |
| 16 | 1884, September 3, 10, 11. | 6 21.6 W. | Edwin Smith, asst. Coast Survey; in the grounds of Girard College, near chapel, and near site of station of 1877; in $\phi = 39^{\circ} 58'.3$ , $\lambda = 75^{\circ} 10'.3$ W. MS. in archives of the Survey. [Double weight assigned to this value—SCH.] |

## 29.—HARRISBURG, PA.

 $\phi = 40^{\circ} 15'.9$        $\lambda = 76^{\circ} 52'.9$  W. of Gr.

(State Capitol.)

|   |                             |           |                                                                                                                                                                                                                        |
|---|-----------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1795, August 19.            | 0 26 E.   | From a map of the borough of Harrisburg, on file in office of register and recorder of this county, made by Thos. Foster. Communicated by W. W. Wright, March 10, 1875. [Weight assigned $\frac{1}{4}$ —SCH.]          |
| 2 | 1840, July 25.              | 3 12.5 W. | Dr. A. D. Bache; in the grounds east of the capitol; Coast Survey Report for 1862, p. 212. [Weight assigned $\frac{1}{2}$ —SCH.]                                                                                       |
| 3 | 1843--                      | 2 35      | From a map of the borough of Harrisburg, on file in the city register's office, made by John Roberts. Communicated by W. W. Wright, March 10, 1875.                                                                    |
| 4 | 1854, autumn.               | 3 06      | John Roberts and Samuel Hoffer, surveyors; on true meridian established by them east of the State House. Communicated by W. W. Wright, Feb., 1875. [See also Annual Report of Sec'y of Int'l Affairs of Pa. for 1876.] |
| 5 | 1857, April 29.             | 3 18.3    | James Ferguson, James Aspach, and Daniel Hoffman, surveyors. Results recorded at county commissioner's office. Communicated by W. W. Wright, Feb., 1875.                                                               |
| 6 | 1857, June 3.               | 3 20      | Samuel Hoffer; reference as before.                                                                                                                                                                                    |
| 6 | 1860-'61.                   | 3 30      | From surveys made by Hather Page; map in city register's office at Harrisburg. Comm'd by W. W. Wright, March 10, 1875.                                                                                                 |
| 7 | 1862, July, 28, 29.         | 3 44.5    | C. A. Schott, asst. Coast Survey; grounds of the State House, near eastern entrance; Coast Survey Rep. for 1862, p. 212.                                                                                               |
| 8 | 1874, October and November. | 4 51 W.   | H. Alricks, jr., J. Simpson Africa; Annual Report of Sec'y of Int'l Affairs of Pa., 1876; W. McCandless, secretary.                                                                                                    |

## UNITED STATES COAST AND GEODETIC SURVEY.

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*Collection of Magnetic Declinations, etc.—Continued.*

## 29.—HARRISBURG, PA.—Continued.

|    |                          |           |                                                                                                                                                                              |
|----|--------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9  | 1876, December 2.        | 5 10 W.   | Annual Report of the Secretary of State for 1876, as above.                                                                                                                  |
| 10 | 1877, September, 25, 26. | 4 53.5    | Edwin Smith, asst. Coast Survey; grounds east of the capitol, near astronomical station and near station of 1862, in $\phi=40^{\circ} 15'.8$ , $\lambda=76^{\circ} 52'.9$ W. |
| 11 | 1885, August 17, 18, 19. | 5 21.9 W. | J. B. Baylor, subasst. Coast and Geodetic Survey; station of 1877. MS. in Survey archives.                                                                                   |

## TYRONE, BLAIR COUNTY, PA.

 $\phi=40^{\circ} 40'$        $\lambda=78^{\circ} 15'.5$  W. of Gr.

|   |                             |        |    |                                                                                                                                                                                                                                            |
|---|-----------------------------|--------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1871, September 25.         | 3 05   | W. | Observer W. G. Waring; results communicated by him to the office by letter, dated Tyrone, Pa., April 14, 1879. [Correcting the values for diurnal variation and contracting to yearly means, we have the following results for discussion: |
|   | 1871, September 27.         | 3 12   |    |                                                                                                                                                                                                                                            |
| 2 | 1873, April 3.              | 3 24   |    |                                                                                                                                                                                                                                            |
|   | 1873, May 10; noon.         | 3 22   |    |                                                                                                                                                                                                                                            |
| 3 | 1873, June 18; 10 a. m.     | 3 19   |    |                                                                                                                                                                                                                                            |
|   | 1874, May 29.               | 3 20   |    |                                                                                                                                                                                                                                            |
| 4 | 1875, June 2.               | 3 26   |    |                                                                                                                                                                                                                                            |
|   | 1878, November 6; 10½ a. m. | 3 45   |    |                                                                                                                                                                                                                                            |
| 5 | 1878, November 14; 9 a. m.  | 3 39   |    |                                                                                                                                                                                                                                            |
|   | 1878, November 14; noon.    | 3 43   |    |                                                                                                                                                                                                                                            |
| 6 | 1878, December 13; 4 p. m.  | 3 43.5 |    |                                                                                                                                                                                                                                            |
|   | 1879, March 18; 1 p. m.     | 3 52   | W. |                                                                                                                                                                                                                                            |

|          |        |
|----------|--------|
| °        |        |
| 1871. 65 | +3. 15 |
| 1873. 36 | 3. 35  |
| 1874. 41 | 3. 33  |
| 1875. 42 | 3. 43  |
| 1878. 88 | 3. 70  |
| 1879. 21 | 3. 80  |

The only deduction that can be made at present is for value of annual increase between 1871 and 1880, viz: + 3'.3—SCH.]

## 30.—HUNTINGDON, HUNTINGDON COUNTY, PA.

 $\phi=40^{\circ} 31'$        $\lambda=78^{\circ} 02'$  W. of Gr.

|   |                     |           |                                                                                                      |
|---|---------------------|-----------|------------------------------------------------------------------------------------------------------|
| 1 | 1840, July 30.      | 1 52.3 W. | Dr. A. D. Bache; Coast Survey Report for 1862, App. 19.                                              |
| 2 | 1852, April.        | 2 16      | Report of the Secretary of Internal Affairs for 1884-'85, Harrisburg, 1886; J. S. Africa, secretary. |
| 3 | 1874, August.       | 3 34      | Reference as before.                                                                                 |
| 4 | 1880, September 24. | 4 15.0    |                                                                                                      |
| 5 | 1881, June 20.      | 4 23.4    |                                                                                                      |
| 6 | 1883, April 9.      | 4 33.7    |                                                                                                      |
| 7 | 1884, May 26.       | 4 37.5    |                                                                                                      |
| 8 | 1885, December 24.  | 4 38.0 W. |                                                                                                      |

## 31.—CHAMBERSBURG, \*FRANKLIN COUNTY, PA.

 $\phi=39^{\circ} 55'$        $\lambda=77^{\circ} 40'$  W. of Gr.

|   |                     |         |                                                                                                                        |
|---|---------------------|---------|------------------------------------------------------------------------------------------------------------------------|
| 1 | 1736, November 4.   | 4 15 W. | Zachary Butcher.                                                                                                       |
| 2 | 1744, September 11. | 3 40    | Thomas Cookson.                                                                                                        |
| 3 | 1746, March 25.     | 3 19    | Thomas Cookson.                                                                                                        |
| 4 | 1754--              | 3 16 W. | From land patent, on various lines, values varying between $2\frac{3}{4}^{\circ}$ and $4^{\circ}$ . Not very reliable. |

*Collection of Magnetic Declinations, etc.—Continued.*

31.—CHAMBERSEBURG, FRANKLIN COUNTY, PA.—Continued.

|    |                            |           |    |                                                                                                                                                                                                |
|----|----------------------------|-----------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5  | 1763, May 6, November 1.   | 1 30      | W. | Col. John Armstrong, mean of $1^{\circ} 15'$ and $1^{\circ} 45'$ W.                                                                                                                            |
| 6  | 1770, April 25.            | 1 30      |    | Col. John Armstrong.                                                                                                                                                                           |
| 7  | 1786, March 31.            | 0 15      | W. | Mathew Henderson.                                                                                                                                                                              |
| 8  | 1787, March 7.             | 0 15      | E. | Mathew Henderson.                                                                                                                                                                              |
| 9  | 1794.                      | 0 30      |    | Mathew Henderson; mountain surveys.                                                                                                                                                            |
| 10 | 1807-'8-'9.                | 0 42.5    |    | Joseph Snively; values between $40'$ and $45'$ E.                                                                                                                                              |
| 11 | 1816, November 18.         | 0 30      |    | Wm. S. Davis.                                                                                                                                                                                  |
| 12 | 1818, May.                 | 0 22      |    | Wm. Cummins.                                                                                                                                                                                   |
| 13 | 1822, November 21.         | 0 15      |    | Wm. S. Davis.                                                                                                                                                                                  |
| 14 | 1825, December 6.          | 0 00      | E. | Wm. S. Davis.                                                                                                                                                                                  |
| 15 | 1830, November 5.          | 0 15      | W. | Wm. S. Davis.                                                                                                                                                                                  |
| 16 | 1836, March 25.            | 0 27      |    | Wm. S. Davis.                                                                                                                                                                                  |
| 17 | 1840, August 24.           | 0 54.4    |    | Dr. A. D. Bache, at Irwin's Mill near Mercersburg, in $\phi = 39^{\circ} 47'$ , $\lambda = 77^{\circ} 56'$ W.; Coast Survey Report for 1862, App. 19. [Reduction to Chambersburg, $-5'$ —SCH.] |
| 18 | 1850, April 29.            | 1 30      |    | John B. Kaufman; by means of an old, plain compass.                                                                                                                                            |
| 19 | 1852, April 12.            | 1 42      |    | Observer and remark as before. [In annual report of the Secretary of Internal Affairs for Pa., Harrisburg, 1886, the value $1^{\circ} 39'$ W. is given—SCH.]                                   |
| 20 | 1859, October 24.          | 2 12      |    | John B. Kaufman; by means of a Gurley R. R. compass.                                                                                                                                           |
| 21 | 1863, March 25.            | 2 15      |    | John B. Kaufman, notes a very small increase in declination between 1857 and 1863.                                                                                                             |
| 22 | 1864, March 31.            | 2 19      | }  | Observer as above.                                                                                                                                                                             |
| 23 | 1865, June 1, 19.          | 2 24      |    |                                                                                                                                                                                                |
| 24 | 1866, February 23.         | 2 25      |    |                                                                                                                                                                                                |
| 25 | 1867, October to December. | 2 35      |    |                                                                                                                                                                                                |
| 26 | 1869, May 24.              | 2 40      |    |                                                                                                                                                                                                |
| 27 | 1871, April, May, June.    | 2 55      |    |                                                                                                                                                                                                |
| 28 | 1873, April.               | 3 00      |    |                                                                                                                                                                                                |
| 29 | 1876, April.               | 3 15      | }  | Annual Report of Sec. of Int. Aff., Pa., 1876, Harrisburg, 1876. [Mean used—SCH.]                                                                                                              |
|    | 1876, October.             | 3 10      |    |                                                                                                                                                                                                |
| 30 | 1877, June.                | 3 20      |    | John B. Kaufman; by means of a Gurley solar-transit.                                                                                                                                           |
| 31 | 1878, April 22.            | 3 24      |    | John B. Kaufman, at 4 p. m. [Reduction to mean of day, $-3'$ —SCH.]                                                                                                                            |
| 32 | 1879, April 12.            | 3 31      |    | John B. Kaufman, at 3 and 4 p. m. [Reduction to mean of day, $-3'$ —SCH.]                                                                                                                      |
| 33 | 1880, April 19.            | 3 36      |    | John B. Kaufman, at $3\frac{1}{2}$ p. m. [Reduction to mean of day, $-4'$ —SCH.]                                                                                                               |
| 34 | 1881, April 30.            | 3 41      |    | John B. Kaufman, at 2 p. m. [Reduction to mean of day, $-5'$ —SCH.]                                                                                                                            |
| 35 | 1882, April 29.            | 3 45      |    | John B. Kaufman, between 11 and 12 a. m. [Reduction to mean of day, $-2'$ —SCH.]                                                                                                               |
| 36 | 1883, April 30.            | 3 50.5    |    | John B. Kaufman, between 3 and 4 p. m. [Reduction to mean of day, $-4'$ —SCH.]                                                                                                                 |
|    | 1883, October 20.          | 3 47      |    | John B. Kaufman, at 9 a. m. and 2 p. m., at Upper Strasburg. [Mean of day adopted, $3^{\circ} 47'$ W.—SCH.]                                                                                    |
| 37 | 1884, April 8.             | 3 49      |    | John B. Kaufman, at 10 and 11 a. m. [In the Annual Rep. of the Sec'y of Int. Aff. for Pa., the additional value $3^{\circ} 56'$ W. is given—SCH.]                                              |
| 38 | 1885, April 14.            | 3 53.5    |    | John B. Kaufman, at 11 a. m., at county meridian.                                                                                                                                              |
|    | 1885, July 8.              | 3 55.4 W. |    | John B. Kaufman, from 20 obs'es, ten direct and ten reversed, 1 to 2 p. m.; and $3^{\circ} 53'.5$ W. at 6 p. m., two obs'es. [Corrected mean of 2 days adopted, $3^{\circ} 52'.5$ W.—SCH.]     |

*Collection of Magnetic Declinations, etc.—Continued.*

## 31.—CHAMBERSBURG, FRANKLIN COUNTY, PA.—Continued.

|    |                   |           |                                                                                                                                                                                                      |
|----|-------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 39 | 1886, March 4.    | 3 54.0 W. | John B. Kaufman, 3 <sup>h</sup> 25 <sup>m</sup> p. m.                                                                                                                                                |
|    | April 6.          | 3 56.2    | John B. Kaufman, 2 <sup>h</sup> 40 <sup>m</sup> p. m., 20 ob's in 4 groups.                                                                                                                          |
|    | April 27.         | 3 57.0    | John B. Kaufman, 10 <sup>h</sup> 40 <sup>m</sup> a. m., at county meridian.                                                                                                                          |
|    | June 4.           | 3 51.4    | John B. Kaufman, 11 a. m., 5 ob's, at 7 a. m., 3° 44'.8, 20 obs's, and 3° 58'.9 at 2 p. m., from 11 ob's; at home meridian, Upper Strasburg, $\phi = 40^{\circ} 03'$ , $\lambda = 77^{\circ} 41' W.$ |
|    | October 1.        | 3 55.5    | John B. Kaufman, at 3 p. m., 2 obser's, at county meridian, $\phi = 39^{\circ} 56'$ , $\lambda = 77^{\circ} 39' W.$ [Corr'd mean of 5 days adopted, 3° 53'.0 W.—SCH.]                                |
| 40 | 1887, January 19. | 3 59.2    | John B. Kaufman, 11 <sup>3</sup> / <sub>4</sub> a. m. to 1 p. m.; 11 direct and 15 reversed obse'ns.                                                                                                 |
|    | January 20.       | 3 57.6    | John B. Kaufman, 11 a. m. and 3° 54'.1, at 9 <sup>h</sup> 15 <sup>m</sup> a. m. (11 d. and 12 r. obse'ns); 4° 01'.1, at 1 p. m. (4 obse'ns), and 4° 02'.4 at 3 p. m. (4 obse'ns).                    |
|    | January 21.       | 3 53.0    | John B. Kaufman, 5 obser's, at 10 <sup>1</sup> / <sub>2</sub> to 11 a. m., 4° 00' at noon, 4° 01' at 1 p. m., 4° 05' at 3 p. m., and 4° 00' at 5 p. m.                                               |
|    | January 22.       | 4 00.0    | John B. Kaufman, at 11 a. m., 4° 05' at 0 and 1 p. m., 4° 10' at 3 p. m., 4° 00' at 5 p. m.                                                                                                          |
|    | 1887, March 11.   | 4 00.5 W. | John B. Kaufman, at 10 <sup>1</sup> / <sub>2</sub> a. m., and 4° 06' at 2 p. m. [Corr'd mean of 5 days adopted, 4° 00'.0 W.—SCH.]                                                                    |

\* This table was obtained from Mr. John B. Kaufman, county surveyor, Franklin County, Pennsylvania, who communicated the same to me in a letter dated "Upper Strasburg, Pa., March 11, 1887." It is headed "Declinations collected by John B. Kaufman, county surveyor, Franklin County, Pennsylvania, partly obtained by differentials between old and new bearings of trustworthy lines, partly by direct observations at the county meridian, latitude 39° 56', longitude 77° 39' W., and at the private meridian near Upper Strasburg, in latitude 40° 03' and longitude 77° 41' W., about." He further remarks: "From 1736 till 1852 (the declinations are) from land surveys, except the observation of Irwin's Mill; after 1852, partly by well-established lines compared with annual tests at county meridian, till 1876. Since last date observations were recorded from annual tests at private meridian. No correction made for diurnal variation."

## 32.—BALTIMORE, MD.

$$\phi = 39^{\circ} 17'.8 \quad \lambda = 76^{\circ} 37'.0 \text{ W. of Gr.}$$

(Washington Monument.)

|    |                  | °         | Given values.*                                                                                                                                                             | °      |
|----|------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| 1  | 1679.0.          | 5.25 W.   | D. of 1679.0 = D. of 1814.5 + 4.50                                                                                                                                         | + 0.75 |
| 2  | 1683.5.          | 6.25      | D. of 1683.5 = D. of 1814.5 + 5.50                                                                                                                                         | + 0.75 |
| 3  | 1703.5.          | 5.12      | D. of 1703.5 = D. of 1811.8 + 4.43                                                                                                                                         | + 0.69 |
| 4  | 1720.5.          | 4.21      | D. of 1720.5 = D. of 1816.0 + 3.42                                                                                                                                         | + 0.79 |
| 5  | 1729.2.          | 4.02      | D. of 1729.2 = D. of 1807.1 + 3.39                                                                                                                                         | + 0.63 |
| 6  | 1754.5.          | 2.28      | D. of 1754.5 = D. of 1855.5 - 0.37                                                                                                                                         | + 2.65 |
| 7  | 1756.9.          | 2.88      | D. of 1756.9 = D. of 1815.0 + 2.12                                                                                                                                         | + 0.76 |
| 8  | 1771.0.          | 1.11      | D. of 1771.0 = D. of 1846.5 - 1.00                                                                                                                                         | + 2.11 |
| 9  | 1776.1.          | 1.75      | D. of 1776.1 = D. of 1811.4 + 1.07                                                                                                                                         | + 0.68 |
| 10 | 1780.5           | 0.77      | D. of 1780.5 = D. of 1861.5 - 2.25                                                                                                                                         | + 3.02 |
| 11 | 1787.5.          | 0.37      | D. of 1787.5 = D. of 1851.0 - 2.00                                                                                                                                         | + 2.37 |
| 12 | 1808.5.          | 0° 12'.5  | D. Byrnes, from numerous observations at Baltimore, in different localities; Sill. Jour., vol. xvii, 1830.                                                                 |        |
| 13 | 1840, August 27. | 2 16.5    | Dr. A. D. Bache, Coast Survey Report for 1862, p. 213.                                                                                                                     |        |
| 14 | 1847, April 29.  | 2 18.6 W. | Capt. T. J. Lee, U. S. E., assistant Coast Survey, at Fort McHenry, in $\phi = 39^{\circ} 15'.8$ , $\lambda = 76^{\circ} 34'.8 W.$ ; Coast Survey Report for 1854, p. 144. |        |

*Collection of Magnetic Declinations, etc.—Continued.*

## 32.—BALTIMORE, MD.—Continued.

|    |                           |              |                                                                                                                                                                                             |
|----|---------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15 | 1856, September 13.       | 2° 29'. 3 W. | C. A. Schott, assistant Coast Survey; just outside Fort McHenry; in $\phi = 39^{\circ} 15'.9$ , $\lambda = 76^{\circ} 34'.9$ W.; Coast Survey Report for 1858, p. 191.                      |
| 16 | 1875. 5.                  | 3. 74        | D. of 1875.5 = D. of 1857.0 + 1° 00. Adopted value for 1857.0 + 2° 74.*                                                                                                                     |
| 17 | 1877, October 10, 11, 12. | 4° 10'. 8    | J. B. Baylor, U. S. Coast Survey, at Fort McHenry, near station of 1856, in $\phi = 39^{\circ} 15'.9$ , $\lambda = 76^{\circ} 34'.9$ W.; Coast and Geodetic Survey Report for 1881, App. 9. |
| 18 | 1885, August 5, 6, 7.     | 4 29. 3 W.   | J. B. Baylor, subast. Coast and Geodetic Survey, at Fort McHenry, station of 1877. MS. in archives of Survey.                                                                               |

\* Mr. Thomas Kelbaugh, surveyor at Mount Carmel, Baltimore County, Maryland, communicated to the Coast Survey Office (letters dated August 17 and 24, 1877, and April 28, 1879) 52 cases of observed (or allowed for) changes of magnetic declinations between two given dates. These differences were mostly from redeterminations of magnetic bearings of old lines, made with the common surveyor's compass, by different individuals and with different instruments. Their locality was generally within a radius of 15 statute miles of the city of Baltimore, and on the N., the NE., and NW. of it. These surveys were made by order of the Baltimore County circuit court, in consequence of disputed land boundaries. Other values Mr. Kelbaugh copied from the record books of the county surveyor and his assistants, between 1805 and 1825.

[These 52 differential values were carefully scrutinized by me and finally combined to 12 mean results, as given in the above table results Nos. 1 to 11 inclusive and No. 16. To these several differences I have added the respective values adopted by me for the declination at the time of the resurvey. These latter data resulted from a formula for Baltimore as established by me in 1877—SCH.]

## 33.—WASHINGTON, D. C.

$$\phi = 38^{\circ} 53'.3 \quad \lambda = 77^{\circ} 00'.6 \text{ W. of Gr.}$$

(U. S. Capitol, dome.)

|    |                                  |         |    |                                                                                                                                                                                                                |
|----|----------------------------------|---------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | 1792--                           | 0 /     |    |                                                                                                                                                                                                                |
|    |                                  | 0 51    | E. | Major A. Ellicott, surveyor-general; inscription on fourth mile-stone, north-westerly from east corner of District; reported by G. Mathiot. [Not used—SCH.]                                                    |
| 1  | 1792--                           | 0 19    | E. | Major A. Ellicott; inscription on first mile-stone northwesterly from east corner of District; reported by John Wiessner.                                                                                      |
|    | 1792--                           | 0 10    | E. | Major A. Ellicott; inscription on east corner-stone of District; reported by J. Wiessner; in $\phi = 38^{\circ} 53'.6$ , $\lambda = 76^{\circ} 54'.6$ W.                                                       |
|    |                                  |         |    |                                                                                                                                                                                                                |
| 2  | 1809, December.                  | 0 52    | W. | Nicholas King, surveyor for the city of Washington; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                                                                                              |
| 3  | 1841. 0.                         | 1 20. 2 |    | J. M. Gilliss, U. S. N.; on Capitol Hill, north of the Capitol; in $\phi = 38^{\circ} 53'.7$ , $\lambda = 77^{\circ} 00'.6$ ; Sen. Doc. 2d sess., 28th Congress, 1844-'45.                                     |
| 4  | 1842. 0.                         | 1 23. 9 |    | J. M. Gilliss, U. S. N.; place and reference as before.                                                                                                                                                        |
| 5  | 1855, July.                      | 2 24    |    | C. A. Schott, assist. Coast Survey; on Capitol Hill, near Gilliss' station; in $\phi = 38^{\circ} 53'.6$ , $\lambda = 77^{\circ} 00'.6$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                 |
| 6  | 1856, August 14, 20.             | 2 21. 4 |    | C. A. Schott, assist. Coast Survey; at old office building on Capitol Hill; in $\phi = 38^{\circ} 53'.1$ , $\lambda = 77^{\circ} 00'.6$ W.; reference as before.                                               |
|    | 1856, August.                    | 2 00. 9 |    | C. A. Schott; in park east of the Capitol, in $\phi = 38^{\circ} 53'.3$ , $\lambda = 77^{\circ} 00'.5$ W.; reference as before. [Not used—SCH.]                                                                |
| 7  | 1857, March 9.                   | 2 24. 8 |    | W. Read; near Capitol, south side; Coast Survey Report for 1858, p. 196. Communicated by observer.                                                                                                             |
| 8  | 1860, August 16 to September 26. | 2 26. 7 |    | C. A. Schott; at Coast Survey office (old building), in $\phi = 38^{\circ} 53'.1$ , $\lambda = 77^{\circ} 00'.6$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                                        |
| 9  | 1862, August 18, 19.             | 2 39. 4 |    | Observer; locality and reference as before.                                                                                                                                                                    |
| 10 | 1863, June 18 to July 28.        | 2 41. 8 |    | Observer; locality and reference as before.                                                                                                                                                                    |
| 11 | 1866, November 1.                | 2 44. 2 |    | Prof. W. Harkness, U. S. N.; grounds of the U. S. Naval Observatory, in $\phi = 38^{\circ} 53'.7$ , $\lambda = 77^{\circ} 03'.1$ W.; Smithsonian Contributions to Knowledge, No. 239, p. 61, Washington, 1873. |

*Collection of Magnetic Declinations, etc.—Continued.*

33.—WASHINGTON, D. C.—Continued.

|    |                                   |           |                                                                                                                                                                                                                                    |
|----|-----------------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12 | 1867, January to December.        | 2 48.1 W. | C. A. Schott; at magnetic observatory, corner 2nd street east and C street south, Capitol Hill, in $\phi = 38^{\circ} 53'.1$ , $\lambda = 77^{\circ} 00'.2$ W.; monthly determinations, Coast Survey Report for 1869, pp. 199–207. |
| 13 | 1868, January to December.        | 2 51.2    |                                                                                                                                                                                                                                    |
| 14 | 1869, January to June, inclusive. | 2 53.0    |                                                                                                                                                                                                                                    |
| 15 | 1870, June 13, 14, 15.            | 2 53.6    | C. A. Schott; at magnetic observatory, corner 2nd and C streets S. E.; Coast Survey Report for 1870, App. 14.                                                                                                                      |
| 16 | 1871, June 14, 15, 16.            | 2 56.9    |                                                                                                                                                                                                                                    |
| 17 | 1872, June 14, 15, 17.            | 3 00.0    |                                                                                                                                                                                                                                    |
| 18 | 1873, June 14, 16, 17.            | 3 00.1    | Observer and locality as before.<br>Coast and Geodetic Survey Report for 1881, App. 9.<br>[Mean, $3^{\circ} 06'.3$ —SCH.]                                                                                                          |
| 19 | 1874, June 13, 15, 16.            | 3 07.4    |                                                                                                                                                                                                                                    |
| 19 | 1874, July 20, 21, 22.            | 3 05.2    |                                                                                                                                                                                                                                    |
| 20 | 1875, June 12, 14, 15.            | 3 15.5    | Observer, locality, and reference as before.                                                                                                                                                                                       |
| 21 | 1876, May 1 and 2.                | 3 18.8    |                                                                                                                                                                                                                                    |
| 22 | 1877, June 14, 15, 16.            | 3 42.1    |                                                                                                                                                                                                                                    |
| 22 | 1877, August 17.                  | 3 36.8    | C. A. Schott; at new magnetic observatory near corner of First and B sts. S. E., Capitol Hill, in $\phi = 38^{\circ} 53'.2$ , $\lambda = 77^{\circ} 00'.4$ W.                                                                      |
| 23 | 1878, June 14, 15, 17.            | 3 47.5    | A. Braid; U. S. Coast Survey; same locality and reference.                                                                                                                                                                         |
| 23 | 1878, September 8.                | 3 43.0    | C. A. Schott; locality and reference as before.                                                                                                                                                                                    |
| 24 | 1879, June 9, 10, 11.             | 3 50.4    | Dr. T. E. Thorpe; locality as above; reference as before.                                                                                                                                                                          |
| 25 | 1880, February 23, 24, 25.        | 3 52.4    | Wm. Einbeck and C. A. Schott, assists. Coast Survey; locality and reference as before.                                                                                                                                             |
| 25 | 1880, April 3.                    | 3 57.2    | Marcus Baker, U. S. Coast and Geode'c. Survey; locality as before. MS. in archives.                                                                                                                                                |
| 26 | 1880, June 12, 14, 17.            | 3 57.1    | J. B. Baylor; U. S. Coast and Geode'c Survey; locality as before; Coast and Geodetic Survey Report for 1881, App. 9. [Mean, $+3^{\circ}.92$ —SCH.]                                                                                 |
| 26 | 1882, June 15, 16, 17.            | 3 55.4    | W. Einbeck, assist. Coast and Geode'c Survey; locality and reference as before.                                                                                                                                                    |
| 27 | 1883, June 18, July 5.            | 4 00.2    | C. A. Schott, assist. Coast Survey; locality as before. MS. in archives.                                                                                                                                                           |
| 28 | 1884, February 5, 7.              | 3 57.9    | J. E. Maxfield, sergeant U. S. Signal Corps; locality and reference as before.                                                                                                                                                     |
| 28 | 1884, June 16, 17.                | 4 05.2    | C. A. Schott; locality and reference as before.                                                                                                                                                                                    |
| 29 | 1885, June 13, 15.                | 4 11.5    |                                                                                                                                                                                                                                    |
| 30 | 1886, June 14, 15, 16.            | 4 08.7 W. |                                                                                                                                                                                                                                    |

## 34.—CAPE HENLOPEN, DEL.

 $\phi = 38^{\circ} 46'.7$        $\lambda = 75^{\circ} 05'.0$  W. of Gr.

(Light-house.)

|   |                                      |         |                                                                                                                                                                                                                                                                                                                                    |
|---|--------------------------------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1609, October 4.<br>1609, August 12. | 6 10 W. | Hudson; on the coast of New Jersey, in $\phi = 39^{\circ} 30'$ } Prof. E. Loomis' collection in Sill. Jour., vol. xxxix, 1840. [The mean latitude is $38^{\circ} 51'$ , and the declination $7\frac{1}{2}^{\circ}$ W. may be taken with an estimated probable error of $\pm 2^{\circ}$ at least. It is of very little weight—SCH.] |
| 2 | 1700.0.                              | 6       |                                                                                                                                                                                                                                                                                                                                    |
| 3 | 1795--                               | 0 55 W. | Edm. Halley; Tabula Nautica Variationum Magneticarum, etc. Reproduced by photo-lithography in the Greenwich observations for 1869.<br>From Aurora; at Lewiston, in $\phi = 38^{\circ} 46'$ , $\lambda = 75^{\circ} 08'$ W.; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838. [Position corrected by me—SCH.]          |

*Collection of Magnetic Declinations, etc.—Continued.*

## 34.—CAPE HENLOPEN, DEL.—Continued.

|   |                             |                |                                                                                                                                                                         |
|---|-----------------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | 1833.0.                     | 0 /<br>1 15 W. | Peter Barlow's isogonic map of 1833; Phil. Trans. Roy. Soc., 1833. [On this map the <i>name</i> Cape Henlopen is erroneously placed—SCH.]                               |
|   | 1841, May.                  | 4 42           | Barnett; Phil. Trans. Roy. Soc., 1841. [Not used—SCH.]                                                                                                                  |
| 5 | 1843, October and November. | 2 26.0         | S. P. Lee, U. S. N., act'g assist. Coast Survey; near the light-house; Coast and Geodetic Survey Report for 1881, App. 9.                                               |
| 6 | 1846, July 1.               | 2 45.0         | Dr. John Locke, act'g assist. Coast Survey; at Lewis' landing, in $\phi = 38^{\circ} 48' 8''$ , $\lambda = 75^{\circ} 11' 9''$ W.; reference as above.                  |
| 7 | 1856, August 27.            | 3 03.9         | C. A. Schott, assist. Coast Survey; near and southwest of the light-house, in $\phi = 38^{\circ} 46' 5''$ , $\lambda = 75^{\circ} 05' 3''$ W.; reference as above.      |
| 8 | 1885, July 29, 30, 31.      | 4 59.6 W.      | J. B. Baylor, Subassist. Coast and Geodetic Survey; near light-house, in $\phi = 38^{\circ} 46' 7''$ , $\lambda = 75^{\circ} 05' 2''$ W. MS. in archives of the Survey. |

## 35.—WILLIAMSBURG, JAMES CITY COUNTY, VA.

 $\phi = 37^{\circ} 16' 2''$        $\lambda = 76^{\circ} 42' 4''$  W. of Gr.

|   |                     |      |    |                                                                                                                                                                                            |
|---|---------------------|------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1694--              | 5    | W. | } Bishop Madison, president of William and Mary's College; in $\phi = 37^{\circ} 15'$ , $\lambda = 76^{\circ} 35' 3''$ W.; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.   |
| 2 | 1780--              | 0 50 | W. |                                                                                                                                                                                            |
| 3 | 1809--              | 0 33 | E. |                                                                                                                                                                                            |
| 4 | 1840, January.      | 0 45 | W. | Lieut. Col. Edw. Sabines' isogonic chart for Jan., 1840, in Phil. Trans. Roy. Soc. for 1849, part 1.                                                                                       |
| 5 | 1874, December 4-9. | 2 12 | W. | J. B. Baylor, U. S. Coast Survey. In the grounds of the W. & M. College. $\phi = 37^{\circ} 16' 3''$ $\lambda = 76^{\circ} 42' 7''$ W.; Coast and Geodetic Survey Report for 1881, App. 9. |

## 36.—CAPE HENRY, VA.

 $\phi = 36^{\circ} 55' 6''$        $\lambda = 76^{\circ} 00' 4''$  W. of Gr.

(Light-house.)

|   |                   |          |    |                                                                                                                                                                                                                                       |
|---|-------------------|----------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1700.0.           | 0 /<br>4 | W. | Edm. Halley's Tabula Nautica Variationum Magneticarum, etc.                                                                                                                                                                           |
| 2 | 1728, March 6.    | 3        |    | W. Byrd; at head of Currituck Sound, in $\phi = 36^{\circ} 33'$ . The Westover MS. [Reduction to cape + 20', about—SCH.]                                                                                                              |
| 3 | 1732--            | 4 42     |    | W. Hoxton; seven miles from Cape Henry, in $\phi = 36^{\circ} 50'$ . Hansteen's Magnetismus der Erde, 1819. [Probable reduction to cape — 10'—SCH.]                                                                                   |
|   | 1732--            | 4 40     |    | Douglass' History; in $\phi = 37^{\circ} 07'$ , $\lambda = 75^{\circ} 50'$ W. Prof. E. Loomis' collection, in Sill. Jour., vol. xxxiv, 1838. [This is supposed the same as Hoxton's obser'n; not used—SCH.]                           |
|   | 1775--            | 5 00     |    | J. F. W. Des Barres' Atlantic Neptune, London, 1781. [Not used—SCH.]                                                                                                                                                                  |
| 4 | 1809--            | 0 00     |    | President Madison, at Norfolk, in $\phi = 36^{\circ} 51'$ , $\lambda = 76^{\circ} 19'$ W. Prof. E. Loomis' collection, in Sill. Jour., vol. xxxiv, 1838. [Reduction to cape — 4' by obser'ns in 1856, but too doubtful to apply—SCH.] |
|   | 1823-'24.         | 1 32     |    | H. Boye's State map of Va., of 1859. [Not used—SCH.]                                                                                                                                                                                  |
| 5 | 1832, June 9, 11. | 0 45     | W. | Prof. J. N. Nicollet; Coast Survey Report for 1864, p. 210.                                                                                                                                                                           |

## UNITED STATES COAST AND GEODETIC SURVEY.

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*Collection of Magnetic Declinations, etc.—Continued.*

## 36.—CAPE HENRY, VA.—Continued.

|    |                            |        |    |                                                                                                                                                                                                |
|----|----------------------------|--------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6  | 1856, September 11, 12.    | 1 28   | W. | C. A. Schott, assist. Coast Survey; near the light-house, in $\phi=36^{\circ} 55' 6''$ , $\lambda=76^{\circ} 00' 4''$ W.; Coast Survey Rep. for 1856, p. 227.                                  |
| 7  | 1874, November 26, 27, 28. | 2 39.5 |    | Dr. T. C. Hilgard, observer for U. S. Coast Survey; near the light-ho.; Coast and Geodetic Survey Report for 1881, App. 9.                                                                     |
| 8  | 1879, May and June.        | 2 32   |    | Lt. S. W. Very, U. S. N.; from 50 observations at the Rip Raps, in $\phi=36^{\circ} 59' 0''$ , $\lambda=76^{\circ} 18' 4''$ W. MS. communication. [Reduction to Cape Henry about $+10'$ —SCH.] |
| 9  | 1881, June 16.             | 3 11   |    | Lieut. C. P. Perkins, U. S. S. Alliance; in $\phi=37^{\circ} 00'$ , $\lambda=76^{\circ} 10'$ W.; Naval Professional Papers No. 19. [Reduction to cape $+5'$ , about—SCH.]                      |
| 10 | 1883, January 2.           | 3 10   |    | Lieut. G. A. Norris, U. S. S. Enterprise; in $\phi=36^{\circ} 56'$ , $\lambda=76^{\circ} 06'$ W.; reference as before. [Reduction to cape about $+5'$ —SCH.]                                   |
|    | 1883, June 30.             | 3 06   |    | Lieut. C. Belknap, U. S. S. Vandalia; in $\phi=36^{\circ} 57'$ , $\lambda=76^{\circ} 02'$ W.; reference as before. [Reduction to cape about zero—SCH.]                                         |
|    | 1883, August 29.           | 3 35   |    | Lieut. H. W. Lyon, U. S. S. Galena; in $\phi=36^{\circ} 54'$ , $\lambda=75^{\circ} 54'$ W.; reference as before. [Reduction to cape about $-5'$ —SCH.]                                         |
|    | 1883, December 10.         | 3 39   |    | Lieut. C. Belknap, U. S. S. Vandalia; in $\phi=36^{\circ} 56'$ , $\lambda=75^{\circ} 57'$ W.; reference as before. [Reduction to cape about zero; mean, $+3^{\circ} 22'$ for 1883.5—SCH.]      |
| 11 | 1884, May 10.              | 3 37   |    | Lieut. F. Hanford, U. S. S. Pensacola; in $\phi=36^{\circ} 54'$ , $\lambda=75^{\circ} 45'$ W.; reference as before. [Reduction to cape about $-15'$ —SCH.]                                     |
|    | 1884, October 10.          | 2 55   | W. | Lieut. C. C. Cornwell, U. S. S. Powhatan; in $\phi=37^{\circ} 00'$ , $\lambda=76^{\circ} 06'$ W.; reference as before. [Red'n to cape about $+5'$ ; mean, $+3^{\circ} 11'$ for 1884.5—SCH.]    |

## 37.—NEW BERNE, N. C.

 $\phi=35^{\circ} 06'$        $\lambda=77^{\circ} 02'$  W. of Gr.

|   |                            |        |    |                                                                                                                                                                                      |
|---|----------------------------|--------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1796..                     | 2 40   | E. | Jonath. Price; from Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838; position assigned $\phi=35^{\circ} 20'$ $\lambda=77^{\circ} 05'$ W. [Latitude $14'$ too high—SCH.] |
| 2 | 1806..                     | 2 00   | E. |                                                                                                                                                                                      |
| 3 | 1809..                     | 1 45   | E. |                                                                                                                                                                                      |
| 4 | 1840.0.                    | 0 00   |    | Lieut. Col. Edw. Sabine; isogonic chart for 1840, Jan'y; Phil. Trans. Roy. Soc., 1849, part i.                                                                                       |
| 5 | 1874, December 21, 23, 24. | 1 20.4 | W. | J. B. Baylor, aid U. S. Coast Survey; at cemetery in $\phi=35^{\circ} 07' 4''$ , $\lambda=77^{\circ} 03' 3''$ W.; Coast and Geodetic Survey Report for 1881; App. 9.                 |

## 38.—CHARLESTON, S. C.

 $\phi=32^{\circ} 46'.6$        $\lambda=79^{\circ} 55'.8$  W. of Gr.

(St. Michael's Church.)

|   |         |      |    |                                                                                                                                                          |
|---|---------|------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1700.0. | 0 30 | E. | Edm. Halley's isogonic chart for 1700, reproduced by photo-lithography in the Greenwich observations for 1869. [Weight $\frac{1}{2}$ in discussion—SCH.] |
|   | 1742..  | 5 23 | E. | English Pilot, published at Tower Hill in 1794; extracted from a paper by Andrew Hughes. [Not used—SCH.]                                                 |

*Collection of Magnetic Declinations, etc.—Continued.*

## 38.—CHARLESTON, S. C.—Continued.

|    |                        |                     |    |                                                                                                                                                                                                                                |
|----|------------------------|---------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2  | 1775--<br>1777--       | ° /<br>3 48<br>3 48 | E. | J. F. W. Des Barres' <i>Atlantic Neptune</i> , London, 1781.<br>From a chart. Prof. E. Loomis' collection in <i>Sill. Jour.</i> , vol. xxxiv, 1838.<br>[Supposed the same as that given in the <i>Neptune</i> ; not used—SCH.] |
| 3  | 1784, February.        | 5 15                |    | } Joseph Purchell, surveyor. From a pamphlet by Charles Parker, Charleston, 1849. Observations said to come from a reliable source.                                                                                            |
| 4  | 1785, October.         | 5 45                |    |                                                                                                                                                                                                                                |
| 5  | 1824-'25.              | 3 45                |    | Lieut. Sherburne, U. S. N.; Blunt's chart of 1824-'25.                                                                                                                                                                         |
| 6  | 1833.0.                | 4 00                |    | Peter Barlow; isogonic chart for 1833. <i>Phil. Trans. Roy. Soc.</i> , 1833, part 1.                                                                                                                                           |
| 7  | 1837--                 | 2 54                |    | Capt. Missroom; Prof. E. Loomis' collection in <i>Sill. Jour.</i> , vol. xxxiv, 1838.<br>Position in $\phi = 32^{\circ} 47'$ , $\lambda = 79^{\circ} 57' W.$                                                                   |
| 8  | 1840--                 | 2 44                |    | Dr. C. Davies, in his treatise on surveying.                                                                                                                                                                                   |
| 9  | 1841, May.             | 2 24                |    | Barnet, <i>Phil. Trans. Roy. Soc.</i> , vol. for 1849.                                                                                                                                                                         |
| 10 | 1847, October.         | 2 15                |    | Charles Parker; from a pamphlet published by him at Charleston, 1849.                                                                                                                                                          |
| 11 | 1849, April 1-22.      | 2 16.5              |    | C. O. Boutelle, assist. Coast Survey; at Breach Inlet, on Sullivan's Island, in $\phi = 32^{\circ} 46'.3$ , $\lambda = 79^{\circ} 48'.9 W.$ ; Coast Survey Report for 1854, p. 145.                                            |
| 12 | 1874, May 27, 28, 29.  | 0 58.2              |    | C. O. Boutelle, asst. Coast Survey; at Fort Marshall, near Breach Inlet, in $\phi = 32^{\circ} 46'.4$ , $\lambda = 79^{\circ} 48'.8 W.$ ; Coast and Geodetic Survey Report for 1881, App. 9.                                   |
| 13 | 1880, January 21, 22.  | 0 25.6              |    | J. B. Baylor, U. S. Coast and Geodetic Survey; position and reference as before.                                                                                                                                               |
| 14 | 1885, December 29, 39. | 0 14.2              | E. | J. B. Baylor, subassist. Coast and Geodetic Survey; near Breach Inlet, Sullivan's Island, in $\phi = 32^{\circ} 46'.3$ , $\lambda = 79^{\circ} 48'.9 W.$ MS. in archives of the Survey.                                        |

## 39.—SAVANNAH, GA.

 $\phi = 32^{\circ} 04'.9$        $\lambda = 81^{\circ} 05'.5 W$  of Gr.

(Savannah Exchange.)

|   |                         |          |    |                                                                                                                                                                                                       |
|---|-------------------------|----------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1817--                  | ° /<br>4 | E. | Becquerel's <i>Traité du Magnétisme</i> , Paris, 1846; <i>Cartes du Dépôt</i> ; in $\phi = 32^{\circ} 04'$ , $\lambda = 81^{\circ} 05' W.$                                                            |
| 2 | 1833.0.                 | 5 00     |    | Peter Barlow's isogonic chart for 1833; <i>Phil. Trans. Roy. Soc.</i> , 1833, part. 1.                                                                                                                |
| 3 | 1838--                  | 5 05     |    | Geological Survey; in $\phi = 32^{\circ} 05'$ , $\lambda = 81^{\circ} 07' W.$ ; Prof. E. Loomis' collection in <i>Sill. Jour.</i> , vol. xxxix, 1840.                                                 |
| 4 | 1839--                  | 3 31     |    | Dr. Posey; reference as before.                                                                                                                                                                       |
| 5 | 1852, April 26, 27, 28. | 3 40.3   |    | J. E. Hilgard, asst. Coast Survey; on Hutchinson's Island, opposite Savannah, in $\phi = 32^{\circ} 05'.2$ , $\lambda = 81^{\circ} 05'.3 W.$ ; Coast and Geodetic Survey Report for 1881, Appendix 9. |
| 6 | 1857, May 1, 2.         | 3 27.5   |    | C. A. Schott, asst. Coast Survey; position as in 1852; Coast and Geodetic Survey Report for 1881, Appendix 9.                                                                                         |
| 7 | 1874, March 8, 9, 10.   | 2 16.9   |    | F. Blake and C. Tappan, observers for U. S. Coast Survey; position as in 1852 and 1857; reference as above.                                                                                           |
| 8 | 1886, January 6, 7.     | 1 37.2   | E. | J. B. Baylor, subasst. U. S. Coast Survey; on Hutchinson's Island; position as above. MS. in archives of Survey.                                                                                      |

*Collection of Magnetic Declinations, etc.—Continued.*

40.—MILLEDGEVILLE, GA.

 $\phi = 33^{\circ} 04'.2$        $\lambda = 83^{\circ} 12' \text{ W. of Gr.}$ 

|   |                |           |                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---|----------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1805--         | 5 30 E.   | J. Bethune; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838. Position assigned, $\phi = 33^{\circ} 07'$ , $\lambda = 83^{\circ} 20' \text{ W.}$                                                                                                                                                                                                                                                                              |
| 2 | 1835--         | 4 40      | Observer and reference as above.                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3 | 1838--         | 5 51      | Geological Survey of Georgia; Prof. E. Loomis' collection in Sill. Jour., vol. xxxix, 1840. Position assigned, $\phi = 33^{\circ} 07'$ , $\lambda = 83^{\circ} 20' \text{ W.}$                                                                                                                                                                                                                                                            |
| 4 | 1875, June 18. | 3 03.5 E. | J. M. Poole, Bache Fund observer to National Academy of Sciences; Coast and Geodetic Survey Report for 1882, App. 14, pp. 402 and 425; in the old Capitol grounds. [The value given in this report is $4^{\circ} 14'.1 \text{ E.}$ on June 15; this value is one of two obtained by the observer, and is probably affected by a misreading of $1^{\circ}$ ; the value given by me is his second one, taken from the MS. computation—SCH.] |

41.—PARIS, FRANCE.

 $\phi = 48^{\circ} 50'.2$        $\lambda = 2^{\circ} 20'.2 \text{ E. of Gr.}$ 

(Paris Astro'l Observatory.)

|    |                               |          |                                                                                                         |
|----|-------------------------------|----------|---------------------------------------------------------------------------------------------------------|
| 1* | 1541--                        | 7 E.     | Bellarmatus.                                                                                            |
| 2  | 1550--                        | 8        | Orontius Fijnæus (Oronce Finné).                                                                        |
| 3  | 1580--                        | 11 30    | Sennertus.                                                                                              |
| 4  | 1603--                        | 8 45     | Nantonnier.                                                                                             |
| 5  | 1610--                        | 8 00     | Nantonnier.                                                                                             |
| 6  | 1630--                        | 4 30     | Petit.                                                                                                  |
| 7  | 1642--                        | 2 30     | Petit.                                                                                                  |
| 8  | 1659 and 1660.                | 1 30     | (?)                                                                                                     |
| 9  | 1664--                        | 0 40 E.  | } Picard.                                                                                               |
| 10 | 1666 and 1667.                | 0 08 W.  |                                                                                                         |
| 11 | 1670--                        | 1 30     | } Picard and La Hire.                                                                                   |
| 12 | 1680-81-82-83-84.             | 3 08     |                                                                                                         |
| 13 | 1685-86-87-88-89.             | 4 52     | La Hire and Cassini.                                                                                    |
| 14 | 1691-92-93-95-96-97-98.       | 6 37     | La Hire and Cassini. [Mean of 2 values of 1698 included—SCH.]                                           |
| 15 | 1699, 1700-1-2-3-4, 1705-6-7. | 9 00     | La Hire and Cassini. [Includes mean of 2 values each for 1700-1-2-3-4, and of 3 values for 1705—SCH.]   |
| 16 | 1708-9-10-11-12-13-14-15-16.  | 11 11    | La Hire and Cassini. [One value for 1715, 3 for 1716, and 2 values each for other years—SCH.]           |
| 17 | 1717-18-19-20-21-22-23-24-25. | 12 52    | Cassini, La Hire, and Maraldi. [Two values for 1717-18-21-22-23, 3 for 1725, and 1 for 1719-20-24—SCH.] |
| 18 | 1726-27-28-29-30-31-32-33-34. | 14 37    | Maraldi and Buache. [Two values for 1734—SCH.]                                                          |
| 19 | 1735-36-37-38-39-40-41-42-43. | 15 23    | Maraldi and Cassini. [Two values for 1735-36-38-40-42 each—SCH.]                                        |
| 20 | 1744-45-46-47-48-49-50-51-52. | 16 37 W. | Fouchy.                                                                                                 |

\* The values Nos. 1 to 30, inclusive, between 1541 and 1807, except for 1805, were taken from the article "Magnetism," by Peter Barlow, in the Encyclopædia of Experimental Philosophy (a part of the Ency. Metropolitana), London, 1848. [The values were combined by me into suitable groups, and their means were taken as indicated in the table—SCH.]

## Collection of Magnetic Declinations, etc.—Continued

41.—PARIS, FRANCE—Continued.

|     |                             | ° /         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----|-----------------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 21  | 1753-54-55-57-58-59-60.     | 17 49       | W. } Maraldi.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 22  | 1765..                      | 19 00       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 23  | 1770-71-72-73-74.           | 20 01       | Maraldi and Le Monnier. [Two values each for 1772-73-74—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                           |
| 24  | 1777-78-79-80-81.           | 20 40       | Le Monnier. [Two values for 1778, 6 for 1779, 46 for 1780, and 12 for 1781—SCH.]                                                                                                                                                                                                                                                                                                                                                                                        |
| 25  | 1782-83-84-85-86.           | 21 25       | Le Monnier. [Three values for 1782-83 each, and 2 for 1784-86 each—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                |
| 26  | 1789-90-91-92-93.           | 22 18       | Le Monnier. [Two values for 1790-91 each—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 27  | 1798-99-1800-01.            | 22 14       | Le Monnier. [Two values for 1799—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 28  | 1802-3-4.                   | 21 58       | Le Monnier, Bouvard, and Cotte. [Three values for 1802—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                            |
| 29  | 1805..                      | 22 05       | Cotte; E. Walker, in "Terrestrial and Cosmical Magnetism," Cambridge, 1866.                                                                                                                                                                                                                                                                                                                                                                                             |
| 30* | 1807..                      | 22 34       | Bouvard.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 31  | 1810, March 13, 1 p. m.     | 22 16       | { Observations by Arago; Walker's Ter. and Cos. Magnetism, Cambridge (Eng.), 1866. [Mean of 4 values, 22° 24'.5; same corrected for diurnal variation, 22° 20'; epoch, 1812.2—SCH.]                                                                                                                                                                                                                                                                                     |
|     | 1811, October 15, noon.     | 22 25       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|     | 1812, October 9, 2½ p. m.   | 22 29       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|     | 1813, October 30, noon.     | 22 28       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 32  | 1814, August 10, noon.      | 22 34       | { Observations by Arago; Walker's Ter. and Cos. Magnetism, Cambridge (Eng.), 1866. [Mean of 3 values, 22° 26'.0; same corrected for diurnal variation, 22° 22'; epoch, 1816.5—SCH.]                                                                                                                                                                                                                                                                                     |
|     | 1816, October 12, 3 p. m.   | 22 25       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|     | 1817, February 10, 0½ p. m. | 22 19       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 33  | 1823..                      | 22 23       | { A. Guyot, in Johnson's Universal Cyclopædia, Art. Earth, New York, 1876. [Mean of 4 values, 22° 15', for 1827.2—SCH.]                                                                                                                                                                                                                                                                                                                                                 |
|     | 1827..                      | 22 20       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|     | 1828..                      | 22 05       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|     | 1829..                      | 22 12       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 34  | 1835. 5.                    | 22 04       | Arago; Gen. Sir Edw. Sabine, in Phil. Trans. Roy. Soc., vol. for 1872, part II; in $\phi=48^{\circ} 53'$ , $\lambda=2^{\circ} 20'$ E.                                                                                                                                                                                                                                                                                                                                   |
| 35  | 1838, February.             | 21 38       | Darondeau; Phil. Trans. Roy. Soc., 1849, part II.                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 36  | 1842. 5.                    | 21 29       | Lamont; Gen. Sir Edw. Sabine, in Phil. Trans. Roy. Soc., vol. for 1872, part II.                                                                                                                                                                                                                                                                                                                                                                                        |
| 37  | 1858, January 1.            | 19 36. 3    | Rev. S. J. Perry; Magnetic survey of the east of France; Phil. Trans. Roy. Soc., vol. for 1872, London, 1873.                                                                                                                                                                                                                                                                                                                                                           |
| 38  | 1865..                      | 18 44       | Encyclopædia Britannica, 9th edition, 1877, Art. Compass.                                                                                                                                                                                                                                                                                                                                                                                                               |
| 39  | 1869, September 1.          | 17 08. 4    | Rev. S. J. Perry; Magnetic survey of the east of France; reference as for No. 37.                                                                                                                                                                                                                                                                                                                                                                                       |
| 40  | 1875, July.                 | 17 21       | Jordan's Vermessungskunde, Vol. 1, Stuttgart, 1877.                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 41  | 1879, January 1.            | 16 56       | Annuaire pour l'an 1882, Paris.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 42  | 1885, January 1.            | 16 10. 2    | { Parc Saint Maur; Th. Moureaux, observer; Comptes Rendus de l'Académie, June, 1886; in $\phi=48^{\circ} 48'.6$ , $\lambda=2^{\circ} 29'.6$ E. Annual change, 7'.4 losing. [For these values, and their reduction to Paris by the addition of the constant 4'.8, I am indebted to the courtesy of M. Moureaux, who communicated them in his letter of Feb. 1, 1887. The values, reduced to Paris, are therefore 16° 15'.0, 16° 08'.8, and 16° 02'.0, respectively—SCH.] |
| 43  | 1886. o.                    | 16 04. 0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 44  | 1887. o.                    | 15 57. 2 W. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

\* The values Nos. 1 to 30, inclusive, between 1541 and 1807, except for 1805, were taken from the article "Magnetism," by Peter Barlow, in the Encyclopædia of Experimental Philosophy (a part of the Ency. Metropolitana), London, 1848. [These values were combined by me into suitable groups, and their means were taken as indicated in the table—SCH.]

*Collection of Magnetic Declinations, etc.—Continued.*

## 42.—BERMUDA ISLANDS.

 $\phi = 32^{\circ} 22'.6$        $\lambda = 64^{\circ} 42'.6$  W. of Gr.

(Signal station, St. George's Town.)

|   |                 |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---|-----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1831--          | 6 59 W. | Austin and Foster; Sir Edw. Sabine, in Phil. Trans. Roy. Soc., 1874, Cont'n xiv. In $\phi = 32^{\circ} 23'$ , $\lambda = 64^{\circ} 47'$ W.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 2 | 1837--          | 6 40    | Milne; reference as before.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 3 | 1845, October.  | 7 01    | Capt. Barnett, Roy. Eng's; Bermuda Royal Gazette; at signal station; in $\phi = 32^{\circ} 23'$ , $\lambda = 64^{\circ} 40'$ W.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 4 | 1846--          | 6 53    | Capt. Barnett, Roy. Eng's; Sir Edw. Sabine, in Phil. Trans. Roy. Soc., 1874, Cont'n xiv. In $\phi = 32^{\circ} 23'$ , $\lambda = 64^{\circ} 47'$ W.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 5 | 1873, May 13.   | 7 10    | H. M. S. Challenger; Green outside dockyard, in $\phi = 32^{\circ} 19'.2$ , $\lambda = 64^{\circ} 51'.8$ W. Results of the Voyage of H. M. S. Challenger; Narrative, vol. ii, London, 1882.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|   | 1873, April 12. | 7 15    | H. M. S. Challenger; St. George, Button Island, in $\phi = 32^{\circ} 22'.6$ , $\lambda = 64^{\circ} 42'.6$ W. Results of the Voyage of H. M. S. Challenger, Narrative, vol. ii, London, 1882, pp. 25 and 46. [According to Staff Commander E. W. Creak, R. N. ("On Local Magnetic Disturbance in Islands situated far from a Continent," Proceedings of the Royal Society, No. 242, 1886), the position on the Green outside dockyard appears to be the only one that may be taken as free from disturbing local attraction; I have therefore transcribed this and the result at St. George's, omitting the Challenger results at other stations on the Bermudas. Commander Creak assumes 2' increase for the annual change about this time—SCH.] |
| 6 | 1876--          | 7 45 W. | Brit. Admiralty Chart No. 365, Feb., 1877; annual increase of declination about 3'.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## 43.—RIO DE JANEIRO, BRAZIL.

 $\phi = -22^{\circ} 54'.8$        $\lambda = 43^{\circ} 09'.5$  W. of Gr.\*

(Flag-staff at Fort Villegagnon.)

|   |                                      |         |                                                                                                                                                                                                                   |                                                                                                                              |
|---|--------------------------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1768--                               | 7 34 E. | Cook -----                                                                                                                                                                                                        | } Voyages of the Adventure and Beagle, 1826-'36, Vol. 1, Capt. P. P. King, London, 1839, p. 523. Discussion by Major Sabine. |
| 2 | 1787--                               | 6 12    | Hunter-----                                                                                                                                                                                                       |                                                                                                                              |
| 3 | 1820--                               | 2 54    | Freycinaet...                                                                                                                                                                                                     |                                                                                                                              |
| 4 | 1821--                               | 3 21    | Rumker-----                                                                                                                                                                                                       |                                                                                                                              |
| 5 | 1830, May 23, 25, 26; June 2, 5, 13. | 2 08.4  | A. G. Erman, Reise um die Erde, etc., Berlin, 1835. In $\phi = -22^{\circ} 53'.9$ , $\lambda = 43^{\circ} 05'.2$ W.                                                                                               |                                                                                                                              |
| 6 | 1836--                               | 2 00 E. | Capt. Fitz Roy; Voyages of the Adventure and Beagle, 1826-'36, London, 1839.                                                                                                                                      |                                                                                                                              |
| 7 | 1857--                               | 1 20 W. | Capt. E. O. Stanley and G. R. Richards and Lieut. Bullock, R. N.; Admiralty Chart No. 541. Fort Villegagnon, in $\phi = -22^{\circ} 54'.7$ , $\lambda = 43^{\circ} 09'.0$ W.                                      |                                                                                                                              |
| 8 | 1866, January 8.                     | 2 41.8  | W. Harkness, Prof. U. S. N.; position near north face of Fort Caraguata, in $\phi = -22^{\circ} 54'.1$ , $\lambda = 43^{\circ} 05'.5$ W. Smithsonian Contributions to Knowledge No. 239, Washington, 1873, p. 61. |                                                                                                                              |
| 9 | 1876. 5.                             | 4 26 W. | Lieut. S. W. Very, U. S. N. From numerous observations at various times and different places. [MS. communication to me, dated Dec. 13, 1879—SCH.]                                                                 |                                                                                                                              |

\* Longitude from "telegraphic determinations of longitudes;" Lieut. Comdr's Green and Davis, U. S. N., 1878-'79, Washington, D. C., 1880.

## Collection of Magnetic Declinations, etc.—Continued.

## 42.—RIO DE JANEIRO, BRAZIL—Continued.

|    |                 |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----|-----------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 | 1882, August 3. | ° /<br>4 39 W. | Annales du Bureau des Longitudes, tome iii, Paris, 1883, p. 396–97.<br>At this place the secular change is progressing perhaps at the most rapid rate known within the tropics and close to the magnetic equator. In a pamphlet published in 1594, entitled "The Seaman's Secret," the celebrated navigator John Davis notes, under the head of remarks, after leaving Brazil, "the compass varies 9°, the <i>south</i> pointing <i>westward</i> ." (Encycl. Brit., 9th edition, 1884, Art. Navigation)—SCH. |
|----|-----------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

RESULTS FOR GROUP I.—Magnetic stations on the eastern coast and within the region of the Appalachian range, inclusive of Newfoundland and some other foreign localities.

Geographical positions and expressions for the secular variation of the magnetic declination  $D$  (+ West, — East). The letter  $m$  stands for  $t-1850.0$  or for the difference in time, expressed in years and fraction of a year, for any time  $t$  and the middle of the century, and within the range of observation at any station.

| No. | Name of station and State.                | Latitude. | West long-<br>tude. | The magnetic declination expressed as a function<br>of time.          |
|-----|-------------------------------------------|-----------|---------------------|-----------------------------------------------------------------------|
|     |                                           | ° /       | ° /                 | ° °                                                                   |
| 1   | Saint John's, Newfoundland.               | 47 34.4   | 52 41.9             | $D = +20.58 + 10.60 \sin(1.4 m + 62.5)$                               |
| 2   | Charlottetown, Prince Edward Isl-<br>and. | 46 14     | 63 27               | $D = +15.95 + 7.78 \sin(1.2 m + 49.8)$                                |
| 3   | Halifax, Nova Scotia.                     | 44 39.6   | 63 35.3             | $D = +16.21 + 4.34 \sin(1.0 m + 47.2)$                                |
| 4   | Quebec, Canada.                           | 46 48.4   | 71 14.5             | $D = +14.66 + 3.03 \sin(1.4 m + 4.6)$<br>$+ 0.61 \sin(4.0 m + 0.3)$   |
| 5   | Montreal, Canada.                         | 45 30.5   | 73 34.6             | $D = +11.88 + 4.17 \sin(1.5 m - 18.5)$<br>$+ 0.36 \sin(4.9 m + 19)$   |
| 6   | Eastport, Me.                             | 44 54.4   | 66 59.2             | $D = +15.14 + 3.90 \sin(1.2 m + 31.7)$                                |
| 7   | Portland, Me.                             | 43 38.8   | 70 16.6             | $D = +11.26 + 3.16 \sin(1.33 m + 5.8)$                                |
| 8   | Burlington, Vt.                           | 44 28.5   | 73 12.0             | $D = +10.81 + 3.65 \sin(1.30 m - 20.5)$<br>$+ 0.18 \sin(7.0 m + 132)$ |
| 9   | Hanover, N. H.                            | 43 42.3   | 72 17.1             | $D = +9.80 + 4.02 \sin(1.4 m - 14.1)$                                 |
| 10  | Chesterfield, N. H.                       | 42 53.5   | 72 24               | $D = +9.60 + 3.84 \sin(1.35 m - 16.1)^*$                              |
| 11  | Rutland, Vt.                              | 43 36.5   | 72 55.5             | $D = +10.03 + 3.82 \sin(1.5 m - 24.3)$                                |
| 12  | Portsmouth, N. H.                         | 43 04.3   | 70 42.5             | $D = +10.71 + 3.36 \sin(1.44 m - 7.4)$                                |
| 13  | Newburyport, Mass.                        | 42 48.9   | 70 49.2             | $D = +10.31 + 3.44 \sin(1.4 m - 4.6)$                                 |
| 14  | Salem, Mass.                              | 42 31.9   | 70 52.5             | $D = +9.72 + 3.82 \sin(1.5 m - 0.7)^*$                                |
| 15  | Boston, Mass.                             | 42 21.5   | 71 03.9             | $D = +9.48 + 2.94 \sin(1.3 m + 3.7)$                                  |
| 16  | Cambridge, Mass.                          | 42 22.9   | 71-07.7             | $D = +9.54 + 2.69 \sin(1.30 m + 7.0)$<br>$+ 0.18 \sin(3.2 m + 44)$    |
| 17  | Provincetown, Mass.                       | 42 03.1   | 70 11.3             | $D = +9.45 + 3.17 \sin(1.3 m + 12.8)^*$                               |
| 18  | Nantucket, Mass.                          | 41 17.0   | 70 06.0             | $D = +8.61 + 2.83 \sin(1.35 m + 19.7)$                                |
| 19  | Providence, R. I.                         | 41 50.2   | 71 23.8             | $D = +9.10 + 2.99 \sin(1.45 m - 3.4)$<br>$+ 0.26 \sin(7 m + 84)$      |
| 20  | Williamstown, Mass.                       | 42 42.8   | 73 13.4             | $D = +8.84 + 3.13 \sin(1.4 m - 14.0)^*$                               |
| 21  | Hartford, Conn.                           | 41 45.9   | 72 40.4             | $D = +8.06 + 2.90 \sin(1.25 m - 26.4)$                                |

\* A rough expression.

*Results for Group I—Continued.*

| No. | Name of station and State.  | Latitude. | West longitude. | The magnetic declination expressed as a function of time.                                                                                        |
|-----|-----------------------------|-----------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 22  | New Haven, Conn.            | 41 18.5   | 72 55.7         | $D = + 7.78 + 3.11 \sin (1.40 m - 22.1)$                                                                                                         |
| 23  | Albany, N. Y.               | 42 39.2   | 73 45.8         | $D = + 8.17 + 3.02 \sin (1.44 m - 8.3)$                                                                                                          |
| 24  | Oxford, N. Y.               | 42 26.5   | 75 40.5         | $D = + 6.19 + 3.24 \sin (1.35 m - 18.9)$                                                                                                         |
| 25  | New York City, N. Y.        | 40 42.7   | 74 00.4         | $D = + 6.61 + 2.40 \sin (1.54 m - 9.4)$<br>$+ 0.14 \sin (6.3 m + 64)$                                                                            |
| 26  | Bethlehem, Pa.              | 40 36.4   | 75 23.0         | $D = + 5.40 + 3.13 \sin (1.55 m - 38.3)$                                                                                                         |
| 27  | Hatborough, Pa.             | 40 12     | 75 07           | $D = + 5.17 + 3.16 \sin (1.54 m - 16.7)$<br>$+ 0.22 \sin (4.1 m + 157)$                                                                          |
| 28  | Philadelphia, Pa.           | 39 56.9   | 75 09.0         | $D = + 5.36 + 3.17 \sin (1.50 m - 26.1)$<br>$+ 0.19 \sin (4.0 m + 146)$                                                                          |
| 29  | Harrisburg, Pa.             | 40 15.9   | 76 52.9         | $D = + 2.93 + 2.98 \sin (1.50 m + 0.2)$                                                                                                          |
| 30  | Huntingdon, Pa.             | 40 31     | 78 02           | $D = + 2.50 + 2.71 \sin (1.5 m - 4.7)^*$                                                                                                         |
| 31  | Chambersburg, Pa.           | 39 55     | 77 40           | $D = + 2.79 + 3.10 \sin (1.55 m - 30.6)$<br>$+ 0.15 \sin (4.6 m + 124)$                                                                          |
| 32  | Baltimore, Md.              | 39 17.8   | 76 37.0         | $D = + 3.20 + 2.57 \sin (1.45 m - 21.2)$                                                                                                         |
| 33  | Washington, D. C.           | 38 53.3   | 77 00.6         | $D = + 2.49 + 2.45 \sin (1.45 m - 15.5)$<br>$+ 0.14 \sin (10 m + 86)$                                                                            |
| 34  | Cape Henlopen, Del.         | 38 46.7   | 75 05.0         | $D = + 3.72 + 2.88 \sin (1.4 m - 21.7)$                                                                                                          |
| 35  | Williamsburg, Va.           | 37 16.2   | 76 42.4         | $D = + 2.33 + 2.56 \sin (1.5 m - 38.1)$                                                                                                          |
| 36  | Cape Henry, Va.             | 36 55.6   | 76 00.4         | $D = + 2.48 + 2.22 \sin (1.5 m - 33.6)$                                                                                                          |
| 37  | New Berne, N. C.            | 35 06     | 77 02           | $D = + 0.60 + 2.64 \sin (1.5 m - 15.4)^*$                                                                                                        |
| 38  | Charleston, S. C.           | 32 46.6   | 79 55.8         | $D = - 2.14 + 2.77 \sin (1.40 m - 3.1)$                                                                                                          |
| 39  | Savannah, Ga.               | 32 04.9   | 81 05.5         | $D = - 2.92 + 2.23 \sin (1.4 m - 20.0)^*$                                                                                                        |
| 40  | Milledgeville, Ga.          | 33 04.2   | 83 12           | $D = - 3.14 + 2.45 \sin (1.5 m - 39.5)^*$                                                                                                        |
| 41  | Paris, France.              | 48 50.2   | 2 20.2 E.       | $D = + 6.479 + 16.002 \sin (0.765 m + 118^\circ 46'.5)$<br>$+ [0.85 - 0.35 \sin (0.69 n)] \sin [(4.04 + 0.0054 n$<br>$+ .000035 n^2) n]^\dagger$ |
| 42  | St. George's Town, Bermuda. | 32 23     | 64 42           | $D = + 6.95 + 0.0145 m + 0.00056 m^{2*}$                                                                                                         |
| 43  | Rio de Janeiro, Brazil.     | -22 54.8  | 43 09.5         | $D = + 2.19 + 9.91 \sin (0.80 m - 10.4)^*$                                                                                                       |

\* A rough expression.

† The secular variation observed at Paris is illustrated on accompanying plate No. 29. It is introduced for the purpose of showing the extremely systematic character of this variation. In the upper half of the diagram the dots indicate the observations, and the smooth curve represents the declination according to a constant and the first periodic term  $D = + 6^\circ.479 + 16^\circ.002 \sin (0.765 m + 118^\circ 46'.5)$ . At this station the phenomenon has now been followed up for about 346 years, in which interval it exhibited two well marked extremes, viz, about the year 1581 a maximum eastern position, and about the year 1812 a maximum western position; the interval between these two consecutive elongations is 231 years, which may be regarded as the time of half a period; in the formula the numerical value of  $a$  implies 470 years for the period. The secondary wave superposed upon the primary is shown in the lower half of the diagram; it has two characteristics, viz, a variability in the parameter, that is a diminution in the size of the wave since about 1540, with a possible increase now, and secondly a variability in the length of the period, which was nearly constant in the second half of the sixteenth and throughout the seventeenth centuries, but afterwards diminished rapidly. Both variations, if real, are undoubtedly periodic, though from want of sufficient data our tabular expression is *limited* in time. It appeared to me doubtful whether one or two secondary waves lie between 1740 and 1870, and since the above diminution of the period hinges upon this question, two analytical expressions were presented in the last edition of this paper, one showing one crest, the other two crests within the interval. The latter expression is here given the preference in consequence of its better representing the latest observations. The factor (4.04, etc.) of  $n$ , where  $n = t - 1700$  corresponds to a length of period of about 90 years, which at present has diminished to about 57 years. These variations necessarily complicate the formula. The law, however, may be studied at Paris to great advantage, and the station was only introduced here with the object of prominently showing the stately secular swing of the needle, and to facilitate the connection of its phases with those noted in North America.

## GROUP I.—Comparison of observed and computed Magnetic Declinations.

| Year and fraction.                   | Obs'd decl'n. | Comp'd decl'n. | O—C.   | Year and fraction.        | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.          | Obs'd decl'n. | Comp'd decl'n. | O—C.   |
|--------------------------------------|---------------|----------------|--------|---------------------------|---------------|----------------|-------|-----------------------------|---------------|----------------|--------|
| SAINT JOHN'S, NEWFOUNDLAND.          |               |                |        | QUEBEC, CANADA—continued. |               |                |       | MONTREAL, CANADA—continued. |               |                |        |
| 1700.0                               | +15.00        | +14.89         | + .11  | 1700.0                    | +16.00        | +16.49         | — .49 | 1842.6                      | + 8.97        | + 9.70         | — .73  |
| 1787.0                               | 16.00         | 15.98          | + .02  | 1785.5                    | 12.58         | 12.24          | + .34 | 1859.5                      | 12.35         | 11.90          | + .45  |
| 1833.0                               | 26.50         | 27.20          | — .70  | 1789.5                    | 11.75         | 12.22          | — .47 | 1879.7                      | +13.67        | +13.79         | — .12  |
| 1844.8                               | 29.60         | 29.28          | + .32  | 1791.5                    | 13.00         | 12.20          | + .80 | EASTPORT, ME.               |               |                |        |
| 1857.5                               | 31.35         | 30.71          | + .64  | 1792.3                    | 12.42         | 12.20          | + .22 | 1608.0                      | +17.53        | +18.96         | — 1.43 |
| 1862.7                               | 31.33         | 31.03          | + .30  | 1793.6                    | 12.54         | 12.17          | + .37 | 1700.0                      | 13.00         | 13.09          | — .09  |
| 1863.7                               | 31.30         | 31.07          | + .23  | 1805.3                    | 11.58         | 12.08          | — .50 | 1775.5                      | 12.67         | 11.84          | + .83  |
| 1864.4                               | 31.00         | 31.10          | — .10  | 1810.5                    | 11.62         | 12.08          | — .46 | 1797.5                      | 12.32         | 13.12          | — .80  |
| 1866.5                               | 30.92         | 31.15          | — .23  | 1811.5                    | 12.25         | 12.09          | + .16 | 1833.0                      | 14.50         | 15.90          | — 1.40 |
| 1881.6                               | +30.52        | +30.73         | — .21  | 1814.5                    | 11.83         | 12.14          | — .31 | 1860.8                      | 17.95         | 17.88          | + .07  |
| CHARLOTTETOWN, PRINCE EDWARD ISLAND. |               |                |        | 1820.8                    | 12.54         | 12.33          | + .21 | 1861.5                      | 17.99         | 17.92          | + .07  |
| 1833.0                               | +19.50        | +19.76         | — .26  | 1821.7                    | 12.90         | 12.36          | + .54 | 1862.5                      | 18.01         | 17.98          | + .03  |
| 1842.4                               | 21.05         | 21.02          | + .03  | 1822.2                    | 13.00         | 12.39          | + .61 | 1863.5                      | 18.04         | 18.03          | + .01  |
| 1857.4                               | 23.04         | 22.60          | + .44  | 1823.6                    | 13.00         | 12.45          | + .55 | 1864.3                      | 18.06         | 18.08          | — .02  |
| 1858.4                               | 22.90         | 22.68          | + .22  | 1824.2                    | 12.67         | 12.49          | + .18 | 1865.6                      | 18.10         | 18.14          | — .04  |
| 1859.4                               | 22.85         | 22.76          | + .09  | 1831.7                    | 13.40         | 12.99          | + .41 | 1873.7                      | 18.93         | 18.52          | + .41  |
| 1860.4                               | 22.83         | 22.84          | — .01  | 1832.4                    | 13.00         | 13.05          | — .05 | 1879.7                      | +19.13        | +18.74         | + .39  |
| 1861.4                               | 22.75         | 22.91          | — .16  | 1833.5                    | 12.75         | 13.14          | — .39 | PORTLAND, ME.               |               |                |        |
| 1862.4                               | 23.32         | 22.98          | + .34  | 1834.4                    | 13.31         | 13.22          | + .09 | 1763.5                      | + 7.75        | + 8.28         | — .53  |
| 1883.7                               | +23.43        | +23.73         | — .30  | 1835.9                    | 13.17         | 13.36          | — .19 | 1775.5                      | 8.50          | 8.11           | + .39  |
| HALIFAX, NOVA SCOTIA.                |               |                |        | 1839.3                    | 13.37         | 13.70          | — .33 | 1845.4                      | 11.47         | 11.24          | + .23  |
| 1608.0                               | +16.25        | +17.32         | — 1.07 | 1840.5                    | 13.71         | 13.81          | — .10 | 1851.6                      | 11.69         | 11.69          | .00    |
| 1700.0                               | 13.00         | 11.98          | + 1.02 | 1842.7                    | 14.02         | 14.07          | — .05 | 1859.5                      | 12.33         | 12.26          | + .07  |
| 1756.5                               | 12.83         | 13.07          | — .24  | 1846.5                    | 14.53         | 14.49          | + .04 | 1863.5                      | 12.47         | 12.54          | — .07  |
| 1775.5                               | 13.58         | 14.22          | — .64  | 1847.7                    | 14.64         | 14.63          | + .01 | 1864.8                      | 12.73         | 12.62          | + .11  |
| 1798.5                               | 16.50         | 15.88          | + .62  | 1848.5                    | 14.58         | 14.72          | — .14 | 1865.5                      | 12.71         | 12.67          | + .04  |
| 1818.5                               | 17.47         | 17.39          | + .08  | 1849.4                    | 15.37         | 14.84          | + .53 | 1866.1                      | 12.72         | 12.70          | + .02  |
| 1821.6                               | 17.60         | 17.61          | — .01  | 1850.3                    | 15.25         | 14.93          | + .32 | 1873.7                      | +12.89        | + 13.17        | — .28  |
| 1833.0                               | 17.50         | 18.39          | — .89  | 1851.7                    | 15.00         | 15.10          | — .10 | BURLINGTON, VT.             |               |                |        |
| 1852.7                               | 18.77         | 19.53          | — .76  | 1853.1                    | 15.50         | 15.26          | + .24 | 1793.5                      | + 7.63        | + 7.35         | — .28  |
| 1853.2                               | 18.85         | 19.55          | — .70  | 1858.8                    | 15.57         | 15.89          | — .32 | 1805.5                      | 6.20          | 7.22           | — 1.02 |
| 1860.5                               | 19.92         | 19.88          | + .04  | 1859.5                    | 16.28         | 15.97          | + .31 | 1818.5                      | 7.50          | 7.43           | + .07  |
| 1866.3                               | 21.09         | 20.09          | + 1.00 | 1860.8                    | 16.47         | 16.09          | + .38 | 1822.5                      | 7.70          | 7.62           | + .08  |
| 1873.4                               | 21.58         | 20.30          | + 1.28 | 1865.5                    | 16.67         | 16.54          | + .13 | 1826.5                      | 7.60          | 7.88           | — .28  |
| 1879.7                               | +20.72        | +20.44         | + .28  | 1879.7                    | +17.23        | +17.38         | — .15 | 1830.5                      | 8.17          | 8.18           | — .01  |
| QUEBEC, CANADA.                      |               |                |        | MONTREAL, CANADA.         |               |                |       | 1831.5                      | 8.25          | 8.26           | — .01  |
| 1642.5                               | +16.00        | +17.00         | — 1.00 | 1749.5                    | +10.63        | +10.76         | — .13 | 1832.5                      | + 8.42        | + 8.34         | + .08  |
| 1686.5                               | +15.50        | +17.33         | — 1.83 | 1785.5                    | 8.40          | 8.45           | — .05 |                             |               |                |        |
|                                      |               |                |        | 1793.6                    | 8.25          | 8.16           | + .09 |                             |               |                |        |
|                                      |               |                |        | 1814.5                    | 7.75          | 7.77           | — .02 |                             |               |                |        |
|                                      |               |                |        | 1834.5                    | 8.00          | 8.80           | — .80 |                             |               |                |        |
|                                      |               |                |        | 1835.5                    | + 9.83        | + 8.90         | + .93 |                             |               |                |        |

## GROUP I.—Comparison of observed and computed Magnetic Declinations—Continued.

| Year and fraction.         | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.  | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.       | Obs'd decl'n. | Comp'd decl'n. | O—C.  |
|----------------------------|---------------|----------------|-------|---------------------|---------------|----------------|-------|--------------------------|---------------|----------------|-------|
| BURLINGTON, VT.—continued. |               |                |       | RUTLAND, VT.        |               |                |       | BOSTON, MASS.—continued. |               |                |       |
| 1834.5                     | + 8.83        | + 8.50         | + .33 | 1789.3              | + 7.05        | + 6.58         | + .47 | 1782.5                   | + 7.00        | + 6.55         | + .45 |
| 1837.5                     | 8.75          | 8.75           | .00   | 1810.4              | 6.07          | 6.23           | — .16 | 1793.5                   | 6.50          | 6.72           | — .22 |
| 1845.5                     | 9.37          | 9.37           | .00   | 1811.7              | 6.02          | 6.25           | — .23 | 1807.5                   | 6.08          | 7.18           | —1.10 |
| 1855.7                     | 9.95          | 10.01          | — .06 | 1859.6              | 9.82          | 9.37           | + .45 | 1833.0                   | 8.00          | 8.55           | — .55 |
| 1873.8                     | +11.32        | +11.31         | + .01 | 1873.8              | 10.67         | 10.79          | — .12 | 1839.5                   | 9.10          | 8.97           | + .13 |
| HANOVER, N. H.             |               |                |       | 1879.8              | +11.15        | +11.36         | — .21 | 1846.7                   | 9.52          | 9.45           | + .07 |
| 1765.5                     | + 7.00        | + 6.83         | + .17 | PORTSMOUTH, N. H.   |               |                |       | 1855.6                   | 10.23         | 10.04          | + .19 |
| 1810.5                     | 4.25          | 6.04           | —1.79 | 1771.5              | + 7.77        | + 7.81         | — .04 | 1872.8                   | 11.25         | 11.09          | + .16 |
| 1839.5                     | 9.25          | 7.87           | +1.38 | 1775.5              | 7.75          | 7.66           | + .09 | 1877.5                   | +11.60        | +11.35         | + .25 |
| 1873.7                     | 10.83         | 11.11          | — .28 | 1833.0              | 8.75          | 8.94           | — .19 | CAMBRIDGE, MASS.         |               |                |       |
| 1879.8                     | +11.64        | +11.66         | — .02 | 1845.0              | 9.78          | 9.86           | — .08 | 1708.5                   | + 9.00        | + 9.26         | — .26 |
| CHESTERFIELD, N. H.        |               |                |       | 1850.7              | 10.50         | 10.33          | + .17 | 1742.5                   | 8.00          | 7.66           | + .34 |
| 1812.5                     | + 6.43        | + 6.07         | + .36 | 1859.5              | 11.25         | 11.08          | + .17 | 1757.5                   | 7.33          | 7.24           | + .09 |
| 1813.5                     | 6.42          | 6.11           | + .31 | 1879.6              | +12.52        | +12.65         | — .13 | 1761.5                   | 7.23          | 7.13           | + .10 |
| 1814.5                     | 6.28          | 6.15           | + .13 | NEWBURYPORT, MASS.  |               |                |       | 1763.5                   | 7.00          | 7.09           | — .09 |
| 1815.5                     | 6.12          | 6.19           | — .07 | 1775.5              | + 6.75        | + 7.06         | — .31 | 1780.5                   | 7.03          | 6.86           | + .17 |
| 1816.5                     | 6.05          | 6.23           | — .18 | 1781.5              | 7.30          | 6.93           | + .37 | 1782.5                   | 6.75          | 6.85           | — .10 |
| 1817.5                     | 6.04          | 6.27           | — .23 | 1833.0              | 8.50          | 8.67           | — .17 | 1783.5                   | 6.87          | 6.86           | + .01 |
| 1818.5                     | 6.00          | 6.32           | — .32 | 1850.7              | 10.09         | 10.10          | — .01 | 1788.5                   | 6.63          | 6.89           | — .26 |
| 1819.5                     | 6.05          | 6.37           | — .32 | 1859.5              | +10.97        | +10.83         | + .14 | 1810.5                   | 7.50          | 7.48           | + .02 |
| 1820.5                     | 6.00          | 6.42           | — .42 | SALEM, MASS.        |               |                |       | 1835.5                   | 8.85          | 8.98           | — .13 |
| 1821.5                     | 6.12          | 6.47           | — .35 | 1781.6              | + 6.90        | + 6.00         | + .90 | 1837.5                   | 9.15          | 9.11           | + .04 |
| 1822.5                     | 6.20          | 6.52           | — .32 | 1805.8              | 5.95          | 6.21           | — .26 | 1840.4                   | 9.30          | 9.32           | — .02 |
| 1823.5                     | 6.50          | 6.58           | — .08 | 1808.5              | 5.33          | 6.32           | — .99 | 1842.2                   | 9.57          | 9.45           | + .12 |
| 1824.5                     | 6.67          | 6.64           | + .03 | 1810.8              | 5.94          | 6.43           | — .49 | 1844.5                   | 9.65          | 9.61           | + .04 |
| 1825.5                     | 6.58          | 6.70           | — .12 | 1833.0              | 8.50          | 8.03           | + .47 | 1845.4                   | 9.53          | 9.68           | — .15 |
| 1826.5                     | 6.58          | 6.76           | — .18 | 1849.6              | 10.24         | 9.63           | + .61 | 1850.6                   | 9.50          | 10.03          | — .53 |
| 1827.5                     | 6.75          | 6.82           | — .07 | 1855.6              | 10.83         | 10.23          | + .60 | 1852.5                   | 10.13         | 10.16          | — .03 |
| 1828.5                     | 6.87          | 6.88           | — .01 | 1877.5              | +11.50        | +12.20         | — .70 | 1854.5                   | 10.21         | 10.29          | — .08 |
| 1829.5                     | 7.00          | 6.94           | + .06 | BOSTON, MASS.       |               |                |       | 1855.4                   | 10.91         | 10.35          | + .56 |
| 1830.5                     | 7.10          | 7.01           | + .09 | 1700.0              | +10.00        | +10.06         | — .06 | 1856.5                   | 10.47         | 10.42          | + .05 |
| 1831.5                     | 7.17          | 7.08           | + .09 | 1708.5              | 9.00          | 9.49           | — .49 | 1859.2                   | 10.80         | 10.59          | + .21 |
| 1832.5                     | 7.25          | 7.15           | + .10 | 1741.5              | 7.50          | 7.49           | + .01 | 1867.5                   | 10.70         | 11.05          | — .35 |
| 1833.5                     | 7.50          | 7.22           | + .28 | 1776.0              | + 7.67        | + 6.54         | +1.13 | 1879.6                   | +11.77        | +11.58         | + .19 |
| 1834.5                     | 7.58          | 7.29           | + .29 | PROVINCETOWN, MASS. |               |                |       | 1609.5                   | +12.00        | +12.20         | — .20 |
| 1835.5                     | 7.67          | 7.36           | + .31 | 1700.0              | +10.00        | +10.06         | — .06 | 1700.0                   | 9.50          | 9.57           | — .07 |
| 1836.5                     | 7.75          | 7.44           | + .31 | 1708.5              | 9.00          | 9.49           | — .49 | 1776.5                   | 6.50          | 6.31           | + .19 |
| 1837.5                     | 8.09          | 7.52           | + .57 | 1741.5              | 7.50          | 7.49           | + .01 | 1833.0                   | + 8.25        | + 8.94         | — .69 |
| 1874.7                     | +10.44        | +10.74         | — .30 | 1776.0              | + 7.67        | + 6.54         | +1.13 |                          |               |                |       |

## GROUP I.—Comparison of observed and computed Magnetic Declinations—Continued.

| Year and fraction.             | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.         | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction. | Obs'd decl'n. | Comp'd decl'n. | O—C.  |
|--------------------------------|---------------|----------------|-------|----------------------------|---------------|----------------|-------|--------------------|---------------|----------------|-------|
| PROVINCETOWN, MASS.—continued. |               |                |       | HARTFORD, CONN.—continued. |               |                |       | OXFORD, N. Y.      |               |                |       |
| 1835.7                         | + 9.33        | + 9.13         | + .20 | 1824.5                     | + 5.75        | + 5.60         | + .15 | 1794.0             | + 3.00        | + 2.96         | + .04 |
| 1860.7                         | +11.39        | +10.87         | + .52 | 1829.0                     | 6.05          | 5.76           | + .29 | 1817.5             | 3.00          | 3.31           | — .31 |
| NANTUCKET, MASS.               |               |                |       | 1859.6                     | 7.29          | 7.34           | — .05 | 1828.5             | 4.50          | 3.79           | + .71 |
| 1700.0                         | + 8.25        | + 8.75         | — .50 | 1867.6                     | 7.82          | 7.84           | — .02 | 1834.8             | 3.87          | 4.13           | — .26 |
| 1775.5                         | 6.50          | 5.82           | + .68 | 1879.6                     | + 8.57        | + 8.59         | — .02 | 1836.8             | 4.15          | 4.26           | — .11 |
| 1833.0                         | 7.50          | 8.45           | — .95 | NEW HAVEN, CONN.           |               |                |       | 1837.5             | 4.50          | 4.30           | + .20 |
| 1834.5                         | 8.45          | 8.55           | — .10 | 1761.5                     | + 5.78        | + 6.04         | — .26 | 1838.5             | 4.45          | 4.36           | + .09 |
| 1839.0                         | 9.04          | 8.85           | + .19 | 1775.5                     | 5.42          | 5.28           | + .14 | 1849.9             | 5.18          | 5.14           | + .04 |
| 1842.7                         | 9.15          | 9.09           | + .06 | 1780.5                     | 5.25          | 5.07           | + .18 | 1857.3             | 5.73          | 5.68           | + .05 |
| 1843.7                         | 9.17          | 9.16           | + .01 | 1811.5                     | 5.17          | 4.76           | + .41 | 1858.1             | 5.78          | 5.74           | + .04 |
| 1846.6                         | 9.23          | 9.35           | — .12 | 1819.8                     | 4.42          | 4.97           | — .55 | 1859.0             | 5.83          | 5.81           | + .02 |
| 1855.6                         | 9.97          | 9.91           | + .06 | 1828.5                     | 5.28          | 5.32           | — .04 | 1873.9             | 6.87          | 6.94           | — .07 |
| 1867.4                         | 10.33         | 10.55          | — .22 | 1835.3                     | 5.68          | 5.67           | + .01 | 1874.4             | 6.93          | 6.97           | — .04 |
| 1879.6                         | 11.46         | 11.05          | + .41 | 1836.5                     | 5.92          | 5.74           | + .18 | 1885.7             | + 7.72        | + 7.77         | — .05 |
| 1883.4                         | +11.43        | +11.17         | + .26 | 1837.9                     | 5.83          | 5.82           | + .01 | NEW YORK, N. Y.    |               |                |       |
| PROVIDENCE, R. I.              |               |                |       | 1840.5                     | 6.17          | 5.98           | + .19 | 1609.7             | + 8.00        | + 5.79         | +2.21 |
| 1717.5                         | + 9.60        | + 9.68         | — .08 | 1844.6                     | 5.75          | 6.24           | — .49 | 1684.5             | 8.75          | 9.14           | — .39 |
| 1769.5                         | 6.50          | 6.28           | + .22 | 1845.7                     | 6.29          | 6.32           | — .03 | 1686.5             | 9.00          | 9.11           | — .11 |
| 1815.5                         | 6.50          | 6.60           | — .10 | 1848.6                     | 6.58          | 6.51           | + .07 | 1691.5             | 8.75          | 8.99           | — .24 |
| 1819.5                         | 6.62          | 6.69           | — .07 | 1855.6                     | 7.05          | 7.01           | + .04 | 1700.0             | 8.33          | 8.65           | — .32 |
| 1835.5                         | 7.57          | 7.79           | — .22 | 1872.5                     | 8.46          | 8.29           | + .17 | 1714.5             | 8.75          | 7.96           | + .79 |
| 1840.5                         | 8.42          | 8.30           | + .12 | 1878.5                     | 8.69          | 8.73           | — .04 | 1724.0             | 7.33          | 7.55           | — .22 |
| 1841.5                         | 8.52          | 8.40           | + .12 | 1884.5                     | 8.93          | 9.15           | — .22 | 1750.5             | 6.37          | 5.94           | + .43 |
| 1842.5                         | 8.65          | 8.50           | + .15 | 1885.2                     | + 9.00        | + 9.20         | — .20 | 1755.5             | 5.00          | 5.57           | — .57 |
| 1843.5                         | 8.77          | 8.60           | + .17 | ALBANY, N. Y.              |               |                |       | 1789.5             | 4.33          | 4.37           | — .04 |
| 1855.6                         | 9.52          | 9.56           | — .04 | 1817.8                     | + 5.73        | + 5.71         | + .02 | 1824.5             | 4.67          | 4.67           | .00   |
| 1884.5                         | 11.13         | 11.13          | .00   | 1818.6                     | 5.75          | 5.74           | + .01 | 1834.5             | 4.83          | 5.21           | — .38 |
| 1885.3                         | +11.16        | +11.19         | + .03 | 1825.3                     | 6.00          | 6.08           | — .08 | 1837.5             | 5.67          | 5.42           | + .25 |
| WILLIAMSTOWN, MASS.            |               |                |       | 1828.6                     | 6.27          | 6.26           | + .01 | 1840.6             | 5.45          | 5.65           | — .20 |
| 1786.5                         | + 5.87        | + 5.79         | + .08 | 1830.5                     | 6.30          | 6.38           | — .08 | 1841.5             | 6.10          | 5.71           | + .39 |
| 1833.5                         | 6.25          | 6.95           | — .70 | 1831.6                     | 6.54          | 6.45           | + .09 | 1842.6             | 5.91          | 5.80           | + .11 |
| 1837.5                         | 7.75          | 7.21           | + .54 | 1834.8                     | 6.67          | 6.65           | + .02 | 1844.6             | 6.22          | 5.55           | + .27 |
| 1876.6                         | 10.52         | 10.07          | + .45 | 1836.8                     | 6.78          | 6.78           | .00   | 1845.6             | 6.42          | 6.02           | + .40 |
| 1886.6                         | +10.35        | +10.73         | — .38 | 1847.9                     | 7.58          | 7.58           | .00   | 1846.3             | 5.57          | 6.08           | — .51 |
| HARTFORD, CONN.                |               |                |       | 1855.7                     | 7.91          | 8.17           | — .26 | 1847.8             | 5.68          | 6.19           | — .51 |
| 1786.5                         | + 5.42        | + 5.28         | + .14 | 1856.7                     | 8.58          | 8.24           | + .34 | 1855.6             | 6.72          | 6.72           | .00   |
| 1810.5                         | + 4.77        | + 5.25         | — .48 | 1858.4                     | 8.28          | 8.37           | — .09 | 1860.7             | 6.73          | 7.01           | — .28 |
|                                |               |                |       | 1879.6                     | + 9.86        | + 9.87         | — .01 | 1873.8             | 7.48          | 7.63           | — .15 |
|                                |               |                |       |                            |               |                |       | 1874.6             | 7.38          | 7.66           | — .28 |
|                                |               |                |       |                            |               |                |       | 1879.5             | 7.87          | 7.89           | — .02 |
|                                |               |                |       |                            |               |                |       | 1885.7             | + 8.21        | + 8.19         | + .02 |

## GROUP I.—Comparison of observed and computed Magnetic Declinations—Continued.

| Year and fraction. | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.           | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.           | Obs'd decl'n. | Comp'd decl'n. | O—C.  |
|--------------------|---------------|----------------|-------|------------------------------|---------------|----------------|-------|------------------------------|---------------|----------------|-------|
| BETHLEHEM, PA.     |               |                |       | PHILADELPHIA, PA.—continued. |               |                |       | CHAMBERSBURG, PA.—continued. |               |                |       |
| 1757.5             | + 6.50        | + 5.49         | +1.01 | 1841.7                       | + 3.90        | + 3.57         | + .33 | 1794.5                       | — 0.50        | — 0.09         | — .41 |
| 1784.5             | 2.88          | 3.38           | — .50 | 1846.4                       | 3.85          | 3.85           | .00   | 1808.5                       | 0.71          | 0.44           | — .27 |
| 1799.5             | 1.87          | 2.60           | — .73 | 1855.7                       | 4.53          | 4.45           | + .08 | 1816.9                       | 0.50          | 0.36           | — .14 |
| 1841.6             | 3.43          | 2.96           | + .47 | 1862.6                       | 5.00          | 4.90           | + .10 | 1818.4                       | 0.37          | 0.31           | — .06 |
| 1851.5             | 3.83          | 3.56           | + .27 | 1872.8                       | 5.46          | 5.64           | — .18 | 1822.9                       | — 0.25        | 0.17           | — .08 |
| 1874.5             | 5.32          | 5.38           | — .06 | 1877.7                       | 6.04          | 6.03           | + .01 | 1825.9                       | 0.00          | — 0.05         | + .05 |
| 1878.2             | 5.62          | 5.69           | — .07 | 1884.7                       | + 6.36        | + 6.57         | — .21 | 1830.8                       | + 0.25        | + 0.19         | + .06 |
| 1881.2             | 5.87          | 5.95           | — .08 | HARRISBURG, PA.              |               |                |       | 1836.2                       | 0.45          | 0.48           | — .03 |
| 1882.7             | 6.08          | 6.07           | + .01 | 1795.6                       | — 0.43        | — 0.02         | — .41 | 1840.6                       | 0.99          | 0.74           | + .25 |
| 1884.0             | + 6.10        | + 6.18         | — .08 | 1840.5                       | + 3.21        | + 2.21         | +1.00 | 1850.3                       | 1.50          | 1.55           | + .15 |
| HATBOROUGH, PA.    |               |                |       | 1843.5                       | 2.58          | 2.44           | + .14 | 1852.3                       | 1.70          | 1.48           | + .22 |
| 1680.5             | + 8.47        | + 8.31         | + .16 | 1854.8                       | 3.01          | 3.31           | — .30 | 1859.8                       | 2.20          | 2.00           | + .20 |
| 1690.5             | 8.25          | 8.16           | + .09 | 1857.4                       | 3.32          | 3.51           | — .19 | 1863.2                       | 2.25          | 2.23           | + .02 |
| 1700.5             | 7.92          | 7.86           | + .06 | 1861.0                       | 3.50          | 3.79           | — .29 | 1864.2                       | 2.32          | 2.31           | + .01 |
| 1710.5             | 7.47          | 7.45           | + .02 | 1862.6                       | 3.74          | 3.90           | — .16 | 1865.4                       | 2.40          | 2.39           | + .01 |
| 1720.5             | 7.00          | 6.96           | + .04 | 1874.8                       | 4.85          | 4.74           | + .11 | 1866.1                       | 2.42          | 2.45           | — .03 |
| 1730.5             | 6.42          | 6.38           | + .04 | 1876.9                       | 5.17          | 4.86           | + .31 | 1867.8                       | 2.58          | 2.56           | + .02 |
| 1740.5             | 5.58          | 5.66           | — .08 | 1877.7                       | 4.89          | 4.91           | — .02 | 1869.4                       | 2.67          | 2.68           | — .01 |
| 1750.5             | 4.92          | 4.83           | + .09 | 1885.6                       | + 5.36        | + 5.33         | + .03 | 1871.4                       | 2.92          | 2.83           | + .09 |
| 1760.5             | 4.00          | 3.93           | + .07 | HUNTINGDON, PA.              |               |                |       | 1873.3                       | 3.00          | 2.97           | + .03 |
| 1770.5             | 2.92          | 3.07           | — .15 | 1840.6                       | + 1.87        | + 1.63         | + .24 | 1876.5                       | 3.21          | 3.21           | .00   |
| 1780.5             | 2.08          | 2.38           | — .30 | 1852.3                       | 2.27          | 2.46           | — .19 | 1877.4                       | 3.33          | 3.29           | + .04 |
| 1790.5             | 1.83          | 1.95           | — .12 | 1874.6                       | 3.57          | 3.94           | — .37 | 1878.3                       | 3.35          | 3.36           | — .01 |
| 1800.5             | 1.92          | 1.84           | + .08 | 1880.7                       | 4.25          | 4.29           | — .04 | 1879.3                       | 3.47          | 3.43           | + .04 |
| 1810.5             | 2.00          | 2.05           | — .05 | 1881.5                       | 4.39          | 4.33           | + .06 | 1880.3                       | 3.53          | 3.52           | + .01 |
| 1820.5             | 2.45          | 2.50           | — .05 | 1883.3                       | 4.56          | 4.43           | + .13 | 1881.3                       | 3.60          | 3.59           | + .01 |
| 1830.5             | 3.00          | 3.08           | — .08 | 1884.4                       | 4.62          | 4.48           | + .14 | 1882.3                       | 3.72          | 3.68           | + .04 |
| 1840.5             | 3.83          | 3.73           | + .10 | 1886.0                       | + 4.63        | + 4.55         | + .08 | 1883.6                       | 3.78          | 3.77           | + .01 |
| 1850.5             | + 4.42        | + 4.39         | + .03 | CHAMBERSBURG, PA.            |               |                |       | 1884.3                       | 3.82          | 3.83           | — .01 |
| PHILADELPHIA, PA.  |               |                |       | 1736.8                       | + 4.25        | + 4.06         | + .19 | 1885.4                       | 3.88          | 3.92           | — .04 |
| 1701.5             | + 8.50        | + 8.13         | + .37 | 1744.7                       | 3.67          | 3.53           | + .14 | 1886.4                       | 3.88          | 4.00           | — .12 |
| 1710.5             | 8.50          | 7.81           | + .69 | 1746.2                       | 3.32          | 3.43           | — .11 | 1887.1                       | + 4.00        | + 4.05         | — .05 |
| 1750.5             | 5.75          | 5.28           | + .47 | 1754.5                       | 3.27          | 2.82           | + .45 | BALTIMORE, MD.               |               |                |       |
| 1793.5             | 1.50          | 2.22           | — .72 | 1768.6                       | 1.50          | 1.71           | — .21 | 1679.0                       | + 5.25        | + 5.77         | — .52 |
| 1802.5             | 1.50          | 2.14           | — .64 | 1770.3                       | 1.50          | 1.58           | — .08 | 1683.5                       | 6.25          | 5.75           | + .50 |
| 1804.5             | 2.08          | 2.09           | — .01 | 1786.2                       | + 0.25        | 0.37           | — .12 | 1703.5                       | 5.12          | 5.27           | — .15 |
| 1813.5             | 2.43          | 2.23           | + .20 | 1787.2                       | — 0.25        | + 0.30         | — .55 | 1720.5                       | 4.21          | 4.45           | — .24 |
| 1837.5             | 3.87          | 3.31           | + .56 |                              |               |                |       | 1729.2                       | 4.02          | 3.93           | + .09 |
| 1840.5             | + 3.62        | + 3.49         | + .13 |                              |               |                |       | 1754.5                       | 2.28          | 2.31           | — .03 |
|                    |               |                |       |                              |               |                |       | 1756.9                       | 2.88          | 2.16           | + .72 |
|                    |               |                |       |                              |               |                |       | 1771.0                       | + 1.11        | + 1.41         | — .30 |

## GROUP I.—Comparison of observed and computed Magnetic Declinations—Continued.

| Year and fraction.        | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.           | Obs'd decl'n. | Comp'd decl'n. | O—C.   | Year and fraction.          | Obs'd decl'n. | Comp'd decl'n. | O—C.  |
|---------------------------|---------------|----------------|-------|------------------------------|---------------|----------------|--------|-----------------------------|---------------|----------------|-------|
| BALTIMORE, MD.—continued. |               |                |       | WASHINGTON, D. C.—continued. |               |                |        | NEW BERNE, N. C.—continued. |               |                |       |
| 1776.1                    | + 1.75        | + 1.19         | + .56 | 1885.5                       | + 4.19        | + 4.07         | + .12  | 1840.0                      | 0.00          | — 0.74         | + .74 |
| 1780.5                    | 0.77          | 1.02           | — .25 | 1886.5                       | + 4.15        | + 4.12         | + .03  | 1875.0                      | + 1.34        | + 1.59         | — .25 |
| 1787.5                    | 0.37          | 0.82           | — .45 | CAPE HENLOPEN, DEL.          |               |                |        | CHARLESTON, S. C.           |               |                |       |
| 1808.5                    | 0.21          | 0.66           | — .45 | 1609.7                       | + 7.50        | + 5.76         | + 1.74 | 1700.0                      | — 0.50        | — 0.63         | + .13 |
| 1840.7                    | 2.27          | 1.76           | + .51 | 1700.0                       | 6.00          | 5.98           | + .02  | 1775.5                      | 3.80          | 4.78           | + .98 |
| 1847.3                    | 2.31          | 2.11           | + .20 | 1795.5                       | 0.92          | 0.87           | + .05  | 1784.1                      | 5.25          | 4.90           | — .35 |
| 1856.7                    | 2.49          | 2.69           | — .20 | 1833.0                       | 1.25          | 1.67           | — .42  | 1785.8                      | 5.75          | 4.91           | — .84 |
| 1875.5                    | 3.74          | 3.90           | — .16 | 1843.8                       | 2.43          | 2.26           | + .17  | 1825.0                      | 3.75          | 3.85           | + .10 |
| 1877.8                    | 4.18          | 4.04           | + .14 | 1846.5                       | 2.75          | 2.43           | + .32  | 1833.0                      | 4.00          | 3.39           | — .61 |
| 1885.6                    | + 4.49        | + 4.50         | — .01 | 1856.6                       | 3.07          | 3.10           | — .03  | 1837.5                      | 2.90          | 3.12           | + .22 |
| WASHINGTON, D. C.         |               |                |       | 1885.6                       | + 4.99        | + 5.08         | — .09  | 1840.5                      | 2.73          | 2.92           | + .19 |
| 1792.5                    | — 0.24        | — 0.04         | — .20 | WILLIAMSBURG, VA.            |               |                |        | 1841.4                      | 2.40          | 2.86           | + .46 |
| 1809.9                    | + 0.87        | + 0.24         | + .63 | 1694.5                       | + 5.00        | + 4.89         | + .11  | 1847.8                      | 2.25          | 2.44           | + .19 |
| 1841.0                    | 1.34          | 1.31           | + .03 | 1780.5                       | + 0.83        | + 0.76         | + .07  | 1849.3                      | 2.28          | 2.34           | + .06 |
| 1842.0                    | 1.40          | 1.40           | .00   | 1809.5                       | — 0.55        | — 0.20         | — .35  | 1874.4                      | 0.97          | 0.71           | — .26 |
| 1855.5                    | 2.40          | 2.26           | + .14 | 1840.0                       | + 0.75        | + 0.28         | + .47  | 1880.1                      | 0.43          | 0.40           | — .03 |
| 1856.6                    | 2.36          | 2.30           | + .06 | 1874.9                       | + 2.20        | + 2.30         | — .10  | 1886.0                      | — 0.24        | — 0.10         | — .14 |
| 1857.2                    | 2.41          | 2.32           | + .09 | CAPE HENRY, VA.              |               |                |        | SAVANNAH, GA.               |               |                |       |
| 1860.7                    | 2.44          | 2.46           | — .02 | 1700.0                       | + 4.00        | + 4.66         | — .66  | 1817.5                      | — 4.00        | — 4.95         | + .95 |
| 1862.7                    | 2.66          | 2.53           | + .13 | 1728.2                       | 3.33          | 3.79           | — .46  | 1833.0                      | 5.00          | 4.46           | — .54 |
| 1863.6                    | 2.70          | 2.57           | + .13 | 1732.5                       | 4.53          | 3.58           | + .95  | 1838.5                      | 5.08          | 4.23           | — .85 |
| 1866.8                    | 2.74          | 2.73           | + .01 | 1809.5                       | 0.00          | 0.27           | — .27  | 1839.5                      | 3.52          | 4.19           | + .67 |
| 1867.5                    | 2.80          | 2.77           | + .03 | 1832.4                       | 0.75          | 0.56           | + .19  | 1852.3                      | 3.67          | 3.56           | — .11 |
| 1868.5                    | 2.85          | 2.83           | + .02 | 1856.7                       | 1.47          | 1.59           | — .12  | 1857.3                      | 3.46          | 3.30           | — .16 |
| 1869.3                    | 2.88          | 2.88           | .00   | 1874.9                       | 2.66          | 2.63           | + .03  | 1874.2                      | 2.28          | 2.38           | + .10 |
| 1870.5                    | 2.89          | 2.96           | — .07 | 1879.4                       | 2.70          | 2.88           | — .18  | 1886.0                      | — 1.62        | — 1.79         | + .17 |
| 1871.5                    | 2.95          | 3.03           | — .08 | 1881.4                       | 3.27          | 3.00           | + .27  | MILLEDGEVILLE, GA.          |               |                |       |
| 1872.5                    | 3.00          | 3.11           | — .11 | 1883.5                       | 3.37          | 3.11           | + .26  | 1805.5                      | — 5.50        | — 5.49         | — .01 |
| 1873.5                    | 3.00          | 3.18           | — .18 | 1884.5                       | + 3.18        | + 3.17         | + .01  | 1835.5                      | 4.67          | 5.29           | + .62 |
| 1874.5                    | 3.11          | 3.27           | — .16 | NEW BERNE, N. C.             |               |                |        | 1838.5                      | 5.85          | 5.19           | — .66 |
| 1875.5                    | 3.26          | 3.35           | — .09 | 1796.5                       | — 2.67        | — 2.03         | — .64  | 1875.5                      | — 3.06        | — 3.20         | + .14 |
| 1876.3                    | 3.31          | 3.41           | — .10 | 1806.5                       | 2.00          | 2.01           | + .01  | PARIS, FRANCE.              |               |                |       |
| 1877*.5                   | 3.66          | 3.50           | + .16 | 1809.5                       | — 1.75        | — 1.96         | + .21  | 1541.5                      | — 7.00        | — 6.60         | — .40 |
| 1878.6                    | 3.75          | 3.59           | + .16 |                              |               |                |        | 1550.5                      | — 8.00        | — 7.50         | — .50 |
| 1879.4                    | 3.84          | 3.65           | + .19 |                              |               |                |        |                             |               |                |       |
| 1880.3                    | 3.92          | 3.71           | + .21 |                              |               |                |        |                             |               |                |       |
| 1882.5                    | 3.93          | 3.86           | + .07 |                              |               |                |        |                             |               |                |       |
| 1883.5                    | 4.00          | 3.95           | + .05 |                              |               |                |        |                             |               |                |       |
| 1884.3                    | + 4.03        | + 4.00         | + .03 |                              |               |                |        |                             |               |                |       |

\* Change of station between 1876 and 1877.

## GROUP I.—Comparison of observed and computed Magnetic Declinations—Continued.

| Year and fraction.       | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.       | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.          | Obs'd decl'n. | Comp'd decl'n. | O—C.  |
|--------------------------|---------------|----------------|-------|--------------------------|---------------|----------------|-------|-----------------------------|---------------|----------------|-------|
| PARIS, FRANCE—continued. |               |                |       | PARIS, FRANCE—continued. |               |                |       | ST. GEORGE'S TOWN, BERMUDA. |               |                |       |
| 1580.5                   | —11.50        | —10.73         | — .77 | 1779.5                   | +20.67        | +21.09         | — .42 | 1831.5                      | + 6.98        | + 6.88         | + .10 |
| 1603.5                   | 8.75          | 8.76           | + .01 | 1784.5                   | 21.42         | 21.75          | — .33 | 1837.5                      | 6.67          | 6.85           | — .18 |
| 1610.5                   | 8.00          | 7.64           | — .36 | 1791.5                   | 22.30         | 22.39          | — .09 | 1845.8                      | 7.02          | 6.90           | + .12 |
| 1630.5                   | 4.50          | 4.51           | + .01 | 1800.0                   | 22.23         | 22.64          | — .41 | 1846.5                      | 6.88          | 6.91           | — .03 |
| 1642.5                   | 2.50          | 3.08           | + .58 | 1803.5                   | 21.97         | 22.59          | — .62 | 1873.3                      | 7.21          | 7.60           | — .39 |
| 1660.0                   | 1.50          | 1.11           | — .39 | 1805.5                   | 22.08         | 22.53          | — .45 | 1876.5                      | + 7.75        | + 7.73         | + .02 |
| 1664.5                   | — 0.67        | 0.47           | — .20 | 1807.5                   | 22.57         | 22.45          | + .12 | RIO DE JANEIRO, BRAZIL.     |               |                |       |
| 1667.0                   | + 0.13        | — 0.08         | + .21 | 1812.2                   | 22.33         | 22.21          | + .12 | 1768.5                      | — 7.57        | — 7.41         | — .16 |
| 1670.5                   | 1.50          | + 0.51         | + .99 | 1816.5                   | 22.37         | 22.02          | + .35 | 1787.5                      | 6.20          | 6.42           | + .22 |
| 1682.5                   | 3.13          | 3.03           | + .10 | 1827.2                   | 22.25         | 21.80          | + .45 | 1820.5                      | 2.90          | 3.35           | + .45 |
| 1687.5                   | 4.87          | 4.25           | + .62 | 1835.5                   | 22.07         | 21.84          | + .23 | 1821.5                      | 3.35          | 3.24           | — .11 |
| 1695.1                   | 6.62          | 6.27           | + .35 | 1838.2                   | 21.63         | 21.82          | — .19 | 1830.5                      | 2.14          | 2.15           | + .01 |
| 1703.5                   | 9.00          | 8.54           | + .46 | 1842.5                   | 21.48         | 21.66          | — .18 | 1836.5                      | — 2.00        | — 1.40         | — .60 |
| 1712.5                   | 11.18         | 10.86          | + .32 | 1858.0                   | 19.60         | 19.51          | + .09 | 1857.5                      | + 1.33        | + 1.43         | — .10 |
| 1721.5                   | 12.87         | 12.84          | + .03 | 1865.5                   | 18.73         | 18.10          | + .63 | 1866.0                      | 2.70          | 2.61           | + .09 |
| 1730.5                   | 14.62         | 14.40          | + .22 | 1869.7                   | 17.14         | 17.52          | — .38 | 1876.5                      | 4.43          | 4.05           | + .38 |
| 1739.5                   | 15.38         | 15.61          | — .23 | 1875.5                   | 17.35         | 16.94          | + .41 | 1882.6                      | + 4.65        | + 4.88         | — .23 |
| 1748.5                   | 16.62         | 16.66          | — .04 | 1879.0                   | 16.93         | 16.71          | + .22 |                             |               |                |       |
| 1757.1                   | 17.82         | 17.69          | + .13 | 1885.0                   | 16.25         | 16.08          | + .17 |                             |               |                |       |
| 1765.6                   | 19.00         | 18.92          | + .08 | 1886.0                   | 16.15         | 15.93          | + .22 |                             |               |                |       |
| 1772.5                   | +20.02        | +20.01         | + .01 | 1887.0                   | +16.03        | +15.76         | + .27 |                             |               |                |       |

## RESULTS FOR GROUP I.—Continued.

Contents of columns: Year of first observation and whole number of observations used in the discussion; probable error of an observation or of a representation; year of nearest easterly digression or magnetic elongation with corresponding amount of minimum *west* declination (or maximum *east* declination); annual change for three modern epochs. *West* declination is indicated by a *plus* sign as is also *increasing west* declination; the contrary direction is indicated by a minus sign.

| Number. | Station.                             | Year of first observation. | Number of observations. | Probable error of an observation. | Nearest epoch of eastern elongation. | Minimum (west) declination at epoch. | Nearest epoch of western elongation. | Maximum (west) declination at epoch. | Annual change in— |         |         |
|---------|--------------------------------------|----------------------------|-------------------------|-----------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|-------------------|---------|---------|
|         |                                      |                            |                         |                                   |                                      |                                      |                                      |                                      | 1885.0.           | 1890.0. | 1895.0. |
| 1       | Saint John's, Newfoundland.          | 1833                       | 10                      | ±18                               | 1741                                 | +10.0                                | 1870                                 | +31.2                                | —5.7              | —7.4    | —9.0    |
| 2       | Charlottetown, Prince Edward Island. | 1833                       | 9                       | 12                                | 1734                                 | + 8.2                                | 1884                                 | +23.7                                | —0.3              | —1.4    | —2.4    |
| 3       | Halifax, Nova Scotia.                | 1608                       | 14                      | 32                                | 1713                                 | +11.9                                | 1893(?)                              | +20.4                                | +0.6              | +0.2    | —0.2    |
| 4       | Quebec, Canada.                      | 1642                       | 37                      | 20                                | 1807                                 | +12.1                                | 1889(?)                              | +17.5                                | +0.7              | 0.0     | —0.9    |
| 5       | Montreal, Canada.                    | 1749                       | 9                       | 31                                | 1814                                 | + 7.7                                | ----                                 | ----                                 | +3.6              | +3.3    | +3.4    |
| 6       | Eastport, Me.                        | 1668                       | 13                      | 29                                | 1749                                 | +11.2                                | 1899(?)                              | +19.0                                | +1.3              | +0.9    | +0.3    |
| 7       | Portland, Me.                        | 1763                       | 10                      | 10                                | 1778                                 | + 8.1                                | 1913(?)                              | +14.4                                | +2.7              | +2.3    | +1.8    |
| 8       | Burlington, Vt.                      | 1793                       | 13                      | 13                                | 1810                                 | + 7.2                                | ----                                 | ----                                 | +5.8              | +5.0    | +3.8    |
| 9       | Hanover, N. H.                       | 1765                       | 5                       | ±27                               | 1796                                 | + 5.8                                | ----                                 | ----                                 | +4.8              | +4.4    | +3.9    |

## RESULTS FOR GROUP I.—Continued.

| Number. | Station.                      | Year of first observation. | Number of observations. | Probable error of an observation. | Nearest epoch of eastern elongation. | Minimum (west) declination at epoch. | Nearest epoch of western elongation. | Maximum declination at epoch. | Annual change in - |         |         |
|---------|-------------------------------|----------------------------|-------------------------|-----------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|-------------------------------|--------------------|---------|---------|
|         |                               |                            |                         |                                   |                                      |                                      |                                      |                               | 1885.0.            | 1890.0. | 1895.0. |
| 10      | Chesterfield, N. H.           | 1812                       | 27                      | ±16                               | 1795                                 | + 5.8                                | ---                                  | ---                           | +4.6               | +4.3    | +3.9    |
| 11      | Rutland, Vt.                  | 1789                       | 6                       | 16                                | 1806                                 | + 6.2                                | ---                                  | ---                           | +5.3               | +4.9    | +4.4    |
| 12      | Portsmouth, N. H.             | 1771                       | 7                       | 7                                 | 1793                                 | + 7.3                                | ---                                  | ---                           | +3.7               | +3.2    | +2.7    |
| 13      | Newburyport, Mass.            | 1775                       | 5                       | 13                                | 1789                                 | + 6.9                                | ---                                  | ---                           | +3.6               | +3.1    | +2.6    |
| 14      | Salem, Mass.                  | 1781                       | 8                       | 31                                | 1790                                 | + 5.9                                | ---                                  | ---                           | +3.7               | +3.1    | +2.4    |
| 15      | Boston, Mass.                 | 1700                       | 13                      | 23                                | 1778                                 | + 6.5                                | ---                                  | ---                           | +2.6               | +2.2    | +1.9    |
| 16      | Cambridge, Mass.              | 1708                       | 24                      | 11                                | 1783                                 | + 6.9                                | ---                                  | ---                           | +1.8               | +1.5    | +1.2    |
| 17      | Provincetown, Mass.           | 1609                       | 6                       | 19                                | 1771                                 | + 6.3                                | 1909(?)                              | +12.6                         | +2.3               | +1.8    | +1.4    |
| 18      | Nantucket, Mass.              | 1700                       | 12                      | 19                                | 1769                                 | + 5.8                                | 1902(?)                              | +11.4                         | +1.6               | +1.1    | +0.6    |
| 19      | Providence, R. I.             | 1717                       | 12                      | 7                                 | 1779                                 | + 6.0                                | ---                                  | ---                           | +4.7               | +4.4    | +3.6    |
| 20      | Williamstown, Mass.           | 1786                       | 5                       | 31                                | 1796                                 | + 5.7                                | ---                                  | ---                           | +3.8               | +3.4    | +3.0    |
| 21      | Hartford, Conn.               | 1786                       | 7                       | 12                                | 1799                                 | + 5.2                                | ---                                  | ---                           | +3.6               | +3.5    | +3.3    |
| 22      | New Haven, Conn.              | 1761                       | 18                      | 11                                | 1802                                 | + 4.7                                | ---                                  | ---                           | +4.1               | +3.8    | +3.4    |
| 23      | Albany, N. Y.                 | 1817                       | 13                      | 6                                 | 1793                                 | + 5.2                                | ---                                  | ---                           | +3.4               | +3.0    | +2.5    |
| 24      | Oxford, N. Y.                 | 1794                       | 14                      | 9                                 | 1797                                 | + 3.0                                | ---                                  | ---                           | +4.0               | +3.7    | +3.4    |
| 25      | New York City, N. Y.          | 1609                       | 26                      | 18                                | 1799                                 | + 4.3                                | ---                                  | ---                           | +2.8               | +2.9    | +2.8    |
| 26      | Bethlehem, Pa.                | 1757                       | 10                      | 19                                | 1817                                 | + 2.3                                | ---                                  | ---                           | +4.9               | +4.6    | +4.3    |
| 27      | Hatborough, Pa.               | 1680                       | 18(?)                   | 6                                 | 1797                                 | + 1.8                                | ---                                  | ---                           | +5.2               | +4.4    | +3.3    |
| 28      | Philadelphia, Pa.             | 1701                       | 16                      | 17                                | 1802                                 | + 2.1                                | ---                                  | ---                           | +4.7               | +4.4    | +4.4    |
| 29      | Harrisburg, Pa.               | 1795                       | 11                      | 15                                | 1790                                 | 0.0                                  | ---                                  | ---                           | +2.8               | +2.3    | +1.8    |
| 30      | Huntingdon, Pa.               | 1840                       | 8                       | 10                                | 1793                                 | ---                                  | ---                                  | - 0.2                         | +2.9               | +2.4    | +1.9    |
| 31      | Chambersburg, Pa.             | 1736                       | 40                      | 7                                 | 1809                                 | ---                                  | ---                                  | - 0.4                         | +4.8               | +4.7    | +4.5    |
| 32      | Baltimore, Md.                | 1679                       | 18                      | 17                                | 1802                                 | + 0.6                                | ---                                  | ---                           | +3.4               | +3.1    | +2.8    |
| 33      | Washington, D. C.             | 1792                       | 30                      | 6                                 | 1798                                 | ---                                  | ---                                  | - 0.3                         | +3.4               | +1.9    | +1.0    |
| 34      | Cape Henlopen, Del.           | 1609                       | 8                       | 12                                | 1801                                 | + 0.8                                | ---                                  | ---                           | +3.8               | +3.5    | +3.2    |
| 35      | Williamsburg, Va.             | 1694                       | 5                       | 17                                | 1815                                 | ---                                  | ---                                  | - 0.2                         | +3.9               | +3.7    | +3.5    |
| 36      | Cape Henry, Va.               | 1700                       | 11                      | 19                                | 1812                                 | + 0.3                                | ---                                  | ---                           | +3.3               | +3.1    | +2.9    |
| 37      | New Berne, N. C.              | 1796                       | 5                       | 25                                | 1800                                 | ---                                  | ---                                  | - 2.0                         | +3.3               | +3.0    | +2.5    |
| 38      | Charleston, S. C.             | 1700                       | 14                      | 19                                | 1788                                 | ---                                  | ---                                  | - 4.9                         | +2.8               | +2.4    | +2.0    |
| 39      | Savannah, Ga.                 | 1817                       | 8                       | 26                                | 1800                                 | ---                                  | ---                                  | - 5.2                         | +2.9               | +2.6    | +2.4    |
| 40      | Milledgeville, Ga.            | 1805                       | 4                       | 26                                | 1816                                 | ---                                  | ---                                  | - 5.6                         | +3.7               | +3.6    | +3.4    |
|         |                               |                            |                         |                                   | At eastern elongation.               |                                      | At western elongation.               |                               |                    |         |         |
|         |                               |                            |                         |                                   | Epoch.                               | Amount.                              | Epoch.                               | Amount.                       |                    |         |         |
| 41      | Paris, France.*               | 1541                       | 44                      | 17                                | 1581                                 | -10.7                                | 1799                                 | +22.6                         | -8.8†              | ---     | ---     |
| 42      | Saint George's Town, Bermuda. | 1831                       | 6                       | 11                                | 1838                                 | + 6.8                                | ---                                  | ---                           | +3.4               | +3.6    | +3.8    |
| 43      | Rio de Janeiro, Brazil.       | 1768                       | 10                      | ±14                               | ---                                  | ---                                  | ---                                  | ---                           | +7.9               | +7.7    | +7.5    |

\*The maximum west declination, according to the formula, was reached in 1799, but according to direct observation in 1807 and again in 1814; the latter value, however, would certainly place it too late, the observation referring to noon and to a single day. The observations when plotted appear stunted about the time of turn in the secular motion; omitting the effect of the secondary wave the primary wave would place the maximum in the year 1812.

†According to Mr. Moureaux's observations (Mémoires divers; observations magnétiques faites à l'observatoire du Parc Saint-Maur, pendant l'année, 1885) the decrease between 1884.5 and 1885.5 was 6'.3.

## RESULTS FOR GROUP I.—Completed.

Ephemeris of magnetic declinations. Computed magnetic declination at each station for every tenth year of the series, and after 1850 for every fifth year. A plus sign signifies westerly declination, a minus sign easterly declination. The *first* tabular result for any station indicates that the first observation made there falls between that tabular date and the next one following it.

| Year<br>(January 1). | Saint John's, New<br>foundland. | Charlottetown,<br>Prince Edward<br>Island. | Halifax, Nova<br>Scotia. | Quebec, Canada. | Montreal, Canada. | Eastport, Me. | Portland, Me. | Burlington, Vt. | Hanover, N. H. | Chesterfield, N. H. | Rutland, Vt. | Portsmouth, N. H. |
|----------------------|---------------------------------|--------------------------------------------|--------------------------|-----------------|-------------------|---------------|---------------|-----------------|----------------|---------------------|--------------|-------------------|
| 1600                 | °                               | °                                          | +18*                     | °               | °                 | +19*          | °             | °               | °              | °                   | °            | °                 |
| 10                   | ----                            | ----                                       | +17                      | ----            | ----              | +19           |               |                 |                |                     |              |                   |
| 20                   |                                 |                                            | ----                     |                 |                   | ----          |               |                 |                |                     |              |                   |
| 30                   |                                 |                                            | ----                     |                 |                   | ----          |               |                 |                |                     |              |                   |
| 40                   |                                 |                                            | ----                     | +17             |                   | ----          |               |                 |                |                     |              |                   |
| 1650                 | ----                            | ----                                       | ----                     | +17             | ----              | ----          |               |                 |                |                     |              |                   |
| 60                   |                                 |                                            | ----                     | ----            |                   | ----          |               |                 |                |                     |              |                   |
| 70                   |                                 |                                            | ----                     | ----            |                   | ----          |               |                 |                |                     |              |                   |
| 80                   |                                 |                                            | ----                     | 17.5            |                   | ----          |               |                 |                |                     |              |                   |
| 90                   | +17                             |                                            | +12.2                    | +17.2           |                   | +13.8         |               |                 |                |                     |              |                   |
| 1700                 | +15                             | ----                                       | +12.0                    | +16.5           | ----              | +13.1         |               |                 |                |                     |              |                   |
| 10                   | +13                             |                                            | 11.9                     | 15.5            |                   | 12.5          |               |                 |                |                     |              |                   |
| 20                   | ----                            |                                            | 11.9                     | ----            |                   | 11.9          |               |                 |                |                     |              |                   |
| 30                   | ----                            |                                            | 12.1                     | ----            |                   | 11.5          |               |                 |                |                     |              |                   |
| 40                   | ----                            |                                            | +12.4                    | ----            | +12.0             | +11.3         |               |                 |                |                     |              |                   |
| 1750                 | ----                            | ----                                       | +12.8                    | ----            | +10.7             | +11.2         | ----          | ----            | ----           | ----                | ----         | ----              |
| 60                   | ----                            |                                            | 13.3                     | ----            | 9.7               | 11.3          | + 8.4         |                 | + 7.2          |                     |              |                   |
| 70                   | ----                            |                                            | 13.9                     | ----            | 9.0               | 11.6          | 8.2           |                 | 6.6            |                     |              | + 7.9             |
| 80                   | +14                             |                                            | 14.5                     | +12.2           | 8.6               | 12.1          | 8.1           |                 | 6.1            |                     | + 7.1        | 7.5               |
| 90                   | +17                             |                                            | +15.2                    | +12.2           | + 8.3             | +12.6         | + 8.2         | + 7.4           | + 5.8          |                     | + 6.6        | + 7.4             |
| 1800                 | ----                            | ----                                       | +16.0                    | +12.1           | + 8.0             | +13.3         | + 8.5         | + 7.3           | + 5.8          | ----                | + 6.3        | + 7.4             |
| 10                   | ----                            |                                            | 16.8                     | 12.1            | 7.8               | 14.1          | 8.9           | 7.2             | 6.0            | + 6.0               | 6.23         | 7.7               |
| 20                   | ----                            |                                            | 17.5                     | 12.3            | 7.9               | 14.9          | 9.5           | 7.49            | 6.5            | 6.4                 | 6.46         | 8.1               |
| 30                   | +26.6                           | +19.3                                      | 18.2                     | 12.9            | 8.4               | 15.7          | 10.1          | 8.14            | 7.2            | 7.0                 | 6.93         | 8.72              |
| 40                   | +28.5                           | +20.7                                      | +18.8                    | +13.8           | + 9.4             | +16.5         | +10.85        | + 8.95          | + 7.9          | + 7.7               | + 7.61       | + 9.47            |
| 1850                 | +30.0                           | +21.9                                      | +19.3                    | +14.9           | +10.7             | +17.2         | +11.58        | + 9.66          | + 8.82         | + 8.5               | + 8.46       | +10.28            |
| 55                   | 30.5                            | 22.4                                       | 19.6                     | 15.5            | 11.4              | 17.52         | 11.94         | 9.96            | 9.31           | 9.0                 | 8.93         | 10.70             |
| 60                   | 30.9                            | 22.8                                       | 19.9                     | 16.0            | 12.0              | 17.83         | 12.29         | 10.26           | 9.80           | 9.4                 | 9.41         | 11.12             |
| 65                   | 31.1                            | 23.2                                       | 20.1                     | 16.5            | 12.5              | 18.12         | 12.63         | 10.60           | 10.28          | 9.9                 | 9.91         | 11.53             |
| 70                   | +31.2                           | +23.4                                      | +20.2                    | +16.9           | +13.0             | +18.36        | +12.95        | +10.98          | +10.76         | +10.3               | +10.41       | +11.94            |
| 1875                 | +31.1                           | +23.6                                      | +20.3                    | +17.2           | +13.5             | +18.58        | +13.25        | +11.42          | +11.24         | +10.8               | +10.90       | +12.32            |
| 80                   | 30.8                            | 23.7                                       | 20.4                     | 17.4            | 13.8              | 18.74         | 13.52         | 11.91           | 11.68          | 11.2                | 11.38        | 12.68             |
| 85                   | 30.4                            | 23.7                                       | 20.5                     | 17.5            | 14.1              | 18.88         | 13.76         | 12.41           | 12.1           | 11.6                | 11.84        | 13.00             |
| 90                   | 29.9                            | 23.7                                       | 20.6                     | 17.5            | 14.4              | 19.0          | 14.0          | 12.85           | 12.5           | 12.0                | 12.26        | 13.3              |
| 95                   | +29.2                           | +23.5                                      | +20.6                    | +17.5           | +14.7             | +19.0         | +14.1         | +13.2           | +12.8          | +12.3               | +12.6        | +13.5             |

\* Results for seventeenth century very doubtful.

## RESULTS OF GROUP I.—Completed.

| Year<br>(January 1). | Newburyport,<br>Mass. | Salem, Mass. | Boston, Mass. | Cambridge, Mass. | Provincetown,<br>Mass. | Nantucket, Mass. | Providence, R. I. | Williamstown,<br>Mass. | Hartford, Conn. | New Haven, Conn. | Albany, N. Y. | Oxford, N. Y. |
|----------------------|-----------------------|--------------|---------------|------------------|------------------------|------------------|-------------------|------------------------|-----------------|------------------|---------------|---------------|
| 1600                 | o                     | o            | o             | o                | +12*                   | o                | o                 | o                      | o               | o                | o             | o             |
| 10                   | ---                   | ---          | ---           | ---              | 12                     |                  |                   |                        |                 |                  |               |               |
| 20                   |                       |              |               |                  | 12.5                   |                  |                   |                        |                 |                  |               |               |
| 30                   |                       |              |               |                  | 13                     |                  |                   |                        |                 |                  |               |               |
| 40                   |                       |              |               |                  | +12.5                  |                  |                   |                        |                 |                  |               |               |
| 1650                 | ----                  | ----         | ----          | ----             | +12                    |                  |                   |                        |                 |                  |               |               |
| 60                   |                       |              |               |                  | 12                     |                  |                   |                        |                 |                  |               |               |
| 70                   |                       |              |               |                  | 11.5                   |                  |                   |                        |                 |                  |               |               |
| 80                   |                       |              |               |                  | 11                     |                  |                   |                        |                 |                  |               |               |
| 90                   |                       |              |               |                  | +10                    |                  |                   |                        |                 |                  |               |               |
| 1700                 | ----                  | ----         | +10.1         | +9.8             | +9.5                   | +9               | ----              |                        |                 |                  |               |               |
| 10                   |                       |              | 9.4           | 9.2              | 9                      | 8                | +10.4             |                        |                 |                  |               |               |
| 20                   |                       |              | 8.7           | 8.7              | 8                      | 7.5              | 9.5               |                        |                 |                  |               |               |
| 30                   |                       |              | 8.1           | 8.2              | 7.5                    | 7                | 8.8               |                        |                 |                  |               |               |
| 40                   |                       |              | +7.6          | +7.82            | +7                     | +6.5             | +8.4              |                        |                 |                  |               |               |
| 1750                 | ----                  | ----         | +7.1          | +7.46            | +6.6                   | +6               | +7.8              | ----                   | ----            | ----             | ----          | ----          |
| 60                   |                       |              | 6.8           | 7.17             | 6.4                    | 6                | 7.0               |                        |                 | +6.1             |               |               |
| 70                   | +7.2                  |              | 6.6           | 6.96             | 6.3                    | 5.8              | 6.3               |                        |                 | 5.6              |               |               |
| 80                   | 7.0                   | +6.1         | 6.5           | 6.86             | 6.4                    | 5.9              | 6.0               | +5.9                   | +5.4            | 5.1              |               |               |
| 90                   | +6.9                  | +5.9         | +6.65         | +6.90            | +6.6                   | +6.1             | +6.2              | +5.7                   | +5.2            | +4.8             |               | +3.01         |
| 1800                 | +7.0                  | +6.0         | +6.90         | +7.10            | +7.0                   | +6.5             | +6.46             | +5.7                   | +5.16           | +4.7             | ----          | +2.96         |
| 10                   | 7.3                   | 6.4          | +7.29         | 7.46             | 7.5                    | 7.0              | 6.54              | 5.9                    | 5.24            | 4.7              | +5.41         | 3.10          |
| 20                   | 7.8                   | 7.0          | 7.78          | 7.97             | 8.1                    | 7.6              | 6.71              | 6.3                    | 5.46            | 5.0              | 5.81          | 3.40          |
| 30                   | 8.5                   | 7.8          | 8.37          | 8.60             | 8.73                   | 8.25             | 7.29              | 6.8                    | 5.80            | 5.39             | 6.35          | 3.87          |
| 40                   | +9.2                  | +8.7         | +9.01         | +9.29            | +9.44                  | +8.92            | +8.24             | +7.4                   | +6.24           | +5.95            | +7.00         | +4.46         |
| 1850                 | +10.04                | +9.67        | +9.67         | +9.99            | +10.15                 | +9.56            | +9.18             | +8.1                   | +6.77           | +6.61            | +7.74         | +5.14         |
| 55                   | 10.45                 | 10.17        | 10.00         | 10.33            | 10.50                  | 9.87             | 9.53              | 8.5                    | 7.06            | 6.97             | 8.12          | 5.51          |
| 60                   | 10.87                 | 10.66        | 10.33         | 10.63            | 10.83                  | 10.16            | 9.78              | 8.8                    | 7.36            | 7.35             | 8.49          | 5.89          |
| 65                   | 11.28                 | 11.14        | 10.64         | 10.92            | 11.14                  | 10.42            | 10.00             | 9.2                    | 7.68            | 7.72             | 8.86          | 6.26          |
| 70                   | +11.67                | +11.59       | +10.94        | +11.17           | +11.4                  | +10.67           | +10.21            | +9.6                   | +7.99           | +8.10            | +9.23         | +6.65         |
| 1875                 | +12.05                | +12.01       | +11.22        | +11.40           | +11.7                  | +10.89           | +10.47            | +10.0                  | +8.30           | +8.47            | +9.57         | +7.02         |
| 80                   | 12.41                 | 12.39        | 11.47         | 11.59            | 11.9                   | 11.07            | 10.79             | 10.3                   | 8.62            | 8.84             | 9.90          | 7.38          |
| 85                   | 12.7                  | 12.7         | 11.7          | 11.74            | 12.1                   | 11.21            | 11.17             | 10.6                   | 8.92            | 9.19             | 10.19         | 7.72          |
| 90                   | 13.0                  | 13.0         | 11.9          | 11.9             | 12.3                   | 11.33            | 11.56             | 10.9                   | 9.2             | 9.52             | 10.46         | 8.05          |
| 95                   | +13.2                 | +13.2        | +12.1         | +12.0            | +12.5                  | +11.4            | +11.9             | +11.2                  | +9.5            | +9.8             | +10.7         | +8.35         |

\* Results for seventeenth century very doubtful.

## RESULTS OF GROUP I.—Completed.

| Year<br>(January 1). | New York City,<br>N. Y. | Bethlehem, Pa. | Hatborough, Pa. | Philadelphia, Pa. | Harrisburg, Pa. | Huntingdon, Pa. | Chambersburg,<br>Pa. | Baltimore, Md. | Washington, D. C. | Cape Henlopen,<br>Del. |
|----------------------|-------------------------|----------------|-----------------|-------------------|-----------------|-----------------|----------------------|----------------|-------------------|------------------------|
| 1600                 | 0                       | 0              | 0               | 0                 | 0               | 0               | 0                    | 0              | 0                 | 0                      |
| 10                   | +5*                     | ---            | ---             | ---               | ---             | ---             | ---                  | ---            | ---               | +3*                    |
| 20                   | 6                       |                |                 |                   |                 |                 |                      |                |                   | 4                      |
| 30                   | 6.5                     |                |                 |                   |                 |                 |                      |                |                   | 4.5                    |
| 40                   | 7                       |                |                 |                   |                 |                 |                      |                |                   | 5                      |
| 40                   | +7.5                    |                |                 |                   |                 |                 |                      |                |                   | +5.5                   |
| 1650                 | +8                      | ---            | ---             | ---               | ---             | ---             | ---                  | ---            | ---               | +6                     |
| 60                   | 8.5                     |                |                 |                   |                 |                 |                      |                |                   | 6.5                    |
| 70                   | 8.9                     |                |                 |                   |                 |                 |                      | +5.7           |                   | 6.6                    |
| 80                   | 9.1                     |                | +8.3            |                   |                 |                 |                      | 5.8            |                   | 6.5                    |
| 90                   | +9.0                    |                | +8.2            |                   |                 |                 |                      | +5.7           |                   | +6.4                   |
| 1700                 | +8.7                    | ---            | +7.9            | +8.2              | ---             | ---             | ---                  | +5.4           | ---               | +6.0                   |
| 10                   | 8.2                     |                | 7.5             | 7.8               |                 |                 |                      | 5.0            |                   | 5.5                    |
| 20                   | 7.7                     |                | 7.0             | 7.4               |                 |                 |                      | 4.5            |                   | 4.9                    |
| 30                   | 7.3                     |                | 6.4             | 6.8               |                 |                 | +4.50                | 3.9            |                   | 4.2                    |
| 40                   | +6.7                    |                | +5.7            | +6.2              |                 |                 | +3.85                | +3.2           |                   | +3.5                   |
| 1750                 | +6.0                    | +6.1           | +4.8            | +5.3              | ---             | ---             | +3.16                | +2.6           | ---               | +2.8                   |
| 60                   | 5.3                     | 5.3            | 3.9             | 4.4               |                 |                 | 2.40                 | 2.0            |                   | 2.2                    |
| 70                   | 4.7                     | 4.5            | 3.1             | 3.6               |                 |                 | 1.60                 | 1.46           |                   | 1.6                    |
| 80                   | 4.4                     | 3.7            | 2.4             | 2.8               |                 |                 | 0.81                 | 1.04           |                   | 1.2                    |
| 90                   | +4.4                    | +3.1           | +2.0            | +2.3              | -0.1            |                 | +0.14                | +0.76          | +0.0              | +0.9                   |
| 1800                 | +4.3                    | +2.6           | +1.8            | +2.1              | +0.0            | ---             | -0.30                | +0.64          | -0.1              | +0.8                   |
| 10                   | 4.4                     | 2.3            | 2.0             | 2.16              | 0.3             |                 | -0.44                | 0.68           | +0.2              | 0.9                    |
| 20                   | 4.52                    | 2.3            | 2.5             | 2.44              | 0.8             |                 | -0.27                | 0.88           | 0.5               | 1.1                    |
| 30                   | 4.92                    | 2.5            | 3.0             | 2.91              | 1.4             |                 | +0.14                | 1.23           | 0.65              | 1.5                    |
| 40                   | +5.60                   | +2.9           | +3.7            | +3.46             | +2.2            | +1.6            | +0.70                | +1.70          | +1.25             | +2.04                  |
| 1850                 | +6.35                   | +3.46          | +4.35           | +4.07             | +2.94           | +2.3            | +1.34                | +2.27          | +1.98             | +2.65                  |
| 55                   | 6.68                    | 3.81           | 4.6             | 4.39              | 3.33            | 2.6             | 1.67                 | 2.58           | 2.24              | 2.99                   |
| 60                   | 6.97                    | 4.19           | 5.0             | 4.73              | 3.71            | 3.0             | 2.01                 | 2.90           | 2.44              | 3.33                   |
| 65                   | 7.23                    | 4.58           | 5.3             | 5.08              | 4.08            | 3.3             | 2.36                 | 3.23           | 2.64              | 3.68                   |
| 70                   | +7.47                   | +5.00          | +5.7            | +5.44             | +4.43           | +3.66           | +2.72                | +3.55          | +2.93             | +4.03                  |
| 1875                 | +7.69                   | +5.42          | +6.2            | +5.81             | +4.75           | +3.97           | +3.10                | +3.87          | +3.30             | +4.38                  |
| 80                   | 7.92                    | 5.85           | 6.7             | 6.20              | 5.05            | 4.25            | 3.49                 | 4.17           | 3.70              | 4.72                   |
| 85                   | 8.15                    | 6.26           | 7.1             | 6.59              | 5.30            | 4.51            | 3.89                 | 4.47           | 4.04              | 5.04                   |
| 90                   | 8.41                    | 6.66           | 7.6             | 6.97              | 5.52            | 4.7             | 4.29                 | 4.74           | 4.26              | 5.34                   |
| 95                   | +8.7                    | +7.03          | +7.9            | +7.4              | +5.7            | +4.9            | +4.67                | +5.00          | +4.37             | +5.6                   |

\* Results for the seventeenth century very doubtful.

## RESULTS OF GROUP I.—Completed.

| Year<br>(January 1). | Williamsburg,<br>Va. | Cape Henry, Va. | New Berne, N. C. | Charleston, S. C. | Savannah, Ga. | Milledgeville, Ga. | Paris, France. | St. George's<br>Town, Ber-<br>muda Islands. | Rio de Janeiro,<br>Brazil. |
|----------------------|----------------------|-----------------|------------------|-------------------|---------------|--------------------|----------------|---------------------------------------------|----------------------------|
| 1540                 | °                    | °               | °                | °                 | °             | °                  | — 6.5          | °                                           | °                          |
| 1550                 | -----                | -----           | -----            | -----             | -----         | -----              | — 7.4          |                                             |                            |
| 60                   |                      |                 |                  |                   |               |                    | 8.8            |                                             |                            |
| 70                   |                      |                 |                  |                   |               |                    | 10.0           |                                             |                            |
| 80                   |                      |                 |                  |                   |               |                    | 10.6           |                                             |                            |
| 90                   |                      |                 |                  |                   |               |                    | — 10.4         |                                             |                            |
| 1600                 | -----                | -----           | -----            | -----             | -----         | -----              | — 9.3          |                                             |                            |
| 10                   |                      |                 |                  |                   |               |                    | 7.7            |                                             |                            |
| 20                   |                      |                 |                  |                   |               |                    | 6.1            |                                             |                            |
| 30                   |                      |                 |                  |                   |               |                    | 4.6            |                                             |                            |
| 40                   |                      |                 |                  |                   |               |                    | — 3.3          |                                             |                            |
| 1650                 | -----                | -----           | -----            | -----             | -----         | -----              | — 2.3          |                                             |                            |
| 60                   |                      |                 |                  |                   |               |                    | — 1.1          |                                             |                            |
| 70                   |                      |                 |                  |                   |               |                    | + 0.4          |                                             |                            |
| 80                   |                      |                 |                  |                   |               |                    | + 2.5          |                                             |                            |
| 90                   | +4.9                 |                 |                  |                   |               |                    | + 4.9          |                                             |                            |
| 1700                 | +4.9                 | +4.6            | -----            | — 0.6             | -----         | -----              | + 7.6          |                                             |                            |
| 10                   | 4.7                  | 4.5             |                  | 1.2               |               |                    | 10.3           |                                             |                            |
| 20                   | 4.4                  | 4.1             |                  | 1.9               |               |                    | 12.6           |                                             |                            |
| 30                   | 3.9                  | 3.7             |                  | 2.6               |               |                    | 14.3           |                                             |                            |
| 40                   | +3.3                 | +3.1            |                  | — 3.2             |               |                    | +15.7          |                                             |                            |
| 1750                 | +2.7                 | +2.6            | -----            | — 3.8             | -----         | -----              | +16.8          | -----                                       | -----                      |
| 60                   | 2.0                  | 2.0             |                  | 4.3               |               |                    | 18.1           |                                             | — 7.63                     |
| 70                   | 1.4                  | 1.5             |                  | 4.7               |               |                    | 19.6           |                                             | 7.35                       |
| 80                   | 0.8                  | 1.0             |                  | 4.86              |               |                    | 21.2           |                                             | 6.89                       |
| 90                   | +0.3                 | +0.6            | — 2              | — 4.91            |               |                    | +22.3          |                                             | — 6.25                     |
| 1800                 | — 0.0                | +0.4            | — 2              | — 4.79            | -----         | — 5.4              | +22.6          | -----                                       | — 5.44                     |
| 10                   | — 0.2                | 0.26            | 2                | 4.52              | — 5.1         | 5.6                | 22.3           |                                             | 4.49                       |
| 20                   | — 0.2                | 0.30            | 1.7              | 4.10              | 4.9           | 5.6                | 21.9           |                                             | 3.43                       |
| 30                   | — 0.1                | 0.45            | 1.3              | 3.57              | 4.6           | 5.4                | 21.8           | +6.9                                        | 2.22                       |
| 40                   | +0.3                 | +0.82           | — 0.7            | — 2.95            | — 4.17        | — 5.1              | +21.8          | +6.86                                       | — 0.94                     |
| 1850                 | +0.75                | +1.25           | — 0.1            | — 2.29            | — 3.68        | — 4.7              | +20.9          | +6.95                                       | +0.40                      |
| 55                   | 1.03                 | 1.51            | +0.2             | 1.95              | 3.42          | 4.4                | 20.1           | 7.02                                        | 1.08                       |
| 60                   | 1.33                 | 1.77            | +0.6             | 1.62              | 3.15          | 4.2                | 19.1           | 7.15                                        | 1.77                       |
| 65                   | 1.65                 | 2.05            | +0.9             | 1.29              | 2.88          | 3.9                | 18.2           | 7.30                                        | 2.46                       |
| 70                   | +1.97                | +2.34           | +1.3             | — 0.97            | — 2.61        | — 3.5              | +17.5          | +7.46                                       | +3.15                      |
| 1875                 | +2.30                | +2.63           | +1.6             | — 0.68            | — 2.34        | — 3.2              | +17.0          | +7.66                                       | +3.84                      |
| 80                   | 2.64                 | 2.92            | 1.9              | — 0.40            | 2.08          | 2.9                | 16.6           | 7.89                                        | 4.51                       |
| 85                   | 2.97                 | 3.20            | 2.2              | — 0.15            | 1.84          | 2.6                | 16.1           | 8.14                                        | 5.18                       |
| 90                   | 3.3                  | 3.47            | 2.5              | +0.07             | 1.61          | 2.3                | 15.1           | 8.4                                         | 5.83                       |
| 95                   | +3.6                 | +3.7            | +2.7             | +0.3              | — 1.4         | — 2.0              | +13.8          | +8.7                                        | +6.5                       |

GROUP II.—*Series of Magnetic Stations mainly in the central part of the United States between the Appalachian and Rocky Mountain ranges.*

The stations of this central series are distributed over the region south of the Hudson Bay and the area between the eastern and western mountain ranges inclosing the drainage of the Gulf of Mexico, with two stations in the West Indies and one in Central America.

Observations were collected and discussed for secular change of declination at the following places :

- |                                           |                                    |
|-------------------------------------------|------------------------------------|
| 1. York Factory, Hudson Bay, Br. Poss.    | 13. Pittsburgh, Pa.                |
| -- Michipicoten, Ontario, Canada.         | -- Denver, Colo.                   |
| 2. Sault de Ste. Marie, Mich.             | 14. Marietta, Ohio.                |
| 3. Duluth, Minn., and Superior City, Wis. | 15. Cincinnati, Ohio.              |
| 4. Pierrepont Manor, N. Y.                | 16. Saint Louis, Mo.               |
| 5. Toronto, Canada.                       | -- Nashville, Tenn.                |
| 6. Grand Haven, Mich.                     | 17. Florence, Ala.                 |
| -- Madison, Wis.                          | -- Natchez, Miss.                  |
| -- Milwaukee, Wis.                        | 18. Mobile, Ala.                   |
| 7. Buffalo, N. Y.                         | 19. New Orleans, La.               |
| 8. Detroit, Mich.                         | 20. San Antonio, Tex.              |
| 9. Erie, Pa.                              | 21. Key West, Fla.                 |
| 10. Chicago, Ill.                         | 22. Havana, Cuba.                  |
| 11. Cleveland, Ohio.                      | 23. Kingston, Port Royal, Jamaica. |
| 12. Omaha, Nebr.                          | 24. Panama, New Granada.           |

The first column of the record for any station contains the running number of the observed values made use of in the discussion, the second the date of the observation, the third the observed value, and the fourth the name of the observer, the geographical position of the station, the reference to publication, and other pertinent remarks.

1.—YORK FACTORY, HUDSON BAY.

$\phi = 56^{\circ} 59'.9$        $\lambda = 92^{\circ} 26'$  W. of Gr.

| 1 | 1725--                  | 19     | W. Capt. Middleton; Hansteen's <i>Magnetismus der Erde</i> , 1819.                                                                                                                                                                                      |
|---|-------------------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 | 1787--                  | 5      | W. Hansteen's isogonic chart; reference as above.                                                                                                                                                                                                       |
| 3 | 1819, September.        | 6 00.3 | E. Sir John Franklin, in $\phi = 57^{\circ} 00'$ , $\lambda = 92^{\circ} 26'$ W. Gen. Sir Edw. Sabine, <i>Proc. Roy. Soc.</i> , 1858, and <i>Conts. to Terr. Mag.</i> No. xiii, <i>Phil. Trans. Roy. Soc.</i> , 1872.                                   |
| 4 | 1843, July 24, 26.      | 9 00.6 | Capt. Lefroy, R. E.; Sir J. H. Lefroy's <i>Magnetic Survey of Canada</i> , etc., London, 1883.                                                                                                                                                          |
| 5 | 1857, August.           | 7 37   | Capt. Blakiston, R. E.; reference as before.                                                                                                                                                                                                            |
|   | 1878--                  | 5 30   | Alfred R. C. Selwyn, director Geological Survey of Canada; Report of 1878-'79, appendix vii, Montreal, 1880. At N. E. side of fort; this locality appeared to be subject to local attraction. [Value not used—SCH.]                                     |
| 6 | 1879--                  | 7 00   | Observer and reference as before; at the S. W. side of fort.                                                                                                                                                                                            |
| 7 | 1884, September 12, 13. | 6 39.8 | E. Otto J. Klotz, D. T. S. Communicated by the Hon. E. Deville, Dept. of the Int., Ottawa. At Capt. Lefroy's station, in $\phi = 56^{\circ} 59'.9$ , $\lambda = 92^{\circ} 26'$ W. See also letter of O. J. Klotz to this office, dated March 19, 1885. |

1825.7 *Series of Magnetic stations, etc.—Continued.*

APPROXIMATE POSITION OF STATION.

$\phi = 47^{\circ} 30' N.$   $\lambda = 84^{\circ} 30' W.$

*Location: Fort Brady, Canada, etc.*

|   |                                                            |        |    |                                                                                                                                                                                     |
|---|------------------------------------------------------------|--------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1824                                                       | 4 33   | 3. | Capt. Richard B. Lee, U. S. E., in Phil. Trans. Roy. Soc., 1872.                                                                                                                    |
|   |                                                            |        |    | Position in $\phi = 47^{\circ} 30' N.$ $\lambda = 84^{\circ} 30' W.$                                                                                                                |
| 2 | 1844, October 30.                                          | 0 26.3 | 3. | Lieut. J. H. Leffroy, R. E., Gen. Ser. J. H. Leffroy's Survey of Magnetic Survey of Canada, etc., London, 1873, p. 167. In $\phi = 47^{\circ} 30' N.$ $\lambda = 84^{\circ} 30' W.$ |
|   |                                                            |        |    | [Not used—SCH.]                                                                                                                                                                     |
| 3 | 1880, July 23, 24, 25, 26, 27, 28, 29, 30, August 1, 2, 3. | 1 20.5 | W. | Lieut. S. W. Very, U. S. N.; Actg. Asst. Coast and Geodetic Survey. Position as a reading. Coast and Geodetic Survey Report for 1881, App. 3.                                       |
|   |                                                            |        |    | [Mean of this station insufficient for discussion: the corrected value for 1844 appears too probable than the old value—SCH.]                                                       |

2. FORT DE STE. MARIE, MICH.

$\phi = 46^{\circ} 29' N.$   $\lambda = 84^{\circ} 20' W.$

*Location: Fort Brady.*

|    |                                |        |    |                                                                                                                                                                                                                                   |
|----|--------------------------------|--------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1824                           | 0      | E. | Alex. Mackenzie: Voyages through the continent of America, London, 1801. Falls of Ste. Marie, in $\phi = 45^{\circ} 31' N.$ $\lambda = 84^{\circ} 00' W.$                                                                         |
|    | 1819, May 2                    | 2 32.3 |    | Sir John Franklin; Sir J. H. Leffroy's Magnetic Survey of Canada, etc., London, 1873. [Not used—SCH.]                                                                                                                             |
| 2  | 1841                           | 1 03   |    | Lieut. J. H. Leffroy: Sir Edw. Sabine in Phil. Trans. Roy. Soc., Cont. and, 1872.                                                                                                                                                 |
| 3  | 1844, November 4.              | 1 01.1 |    | Lieut. J. H. Leffroy: Sir J. H. Leffroy's Magnetic Survey of Canada, etc., London, 1873. In Phil. Trans. Roy. Soc., 1872, position in $\phi = 47^{\circ} 31' N.$ $\lambda = 84^{\circ} 32' W.$                                    |
| 4  | 1845                           | 0 46   |    | Observer, position, and reference as before.                                                                                                                                                                                      |
| 5  | 1846, November.                | 0 40   |    | Lieut. G. C. Westcott, U. S. A.: Information from Mr. J. B. Baylor.                                                                                                                                                               |
| 6  | 1846, September 29.            | 0 32.1 | L. | Karl Friesach; Kais. Acad. der. Wiss., vol. 29, Vienna, 1853: position assigned $\phi = 46^{\circ} 30' N.$ $\lambda = 84^{\circ} 34' W.$                                                                                          |
| 7  | 1873, July 22, 23.             | 0 04.9 | W. | Capt. A. N. Lee, U. S. E.; Survey of the N. and N. W. Lakes, Gen. C. B. Comstock in charge. MS. of 1873, also Report of Chief of Engineers, U. S. A., 1874, App. C C. In $\phi = 46^{\circ} 30' N.$ $\lambda = 84^{\circ} 20' W.$ |
| 8  | 1879, November 12.             | 1 01.0 |    | City Surveyor at Fort Brady. Information from Mr. J. B. Baylor.                                                                                                                                                                   |
| 9  | 1880, July 11, 13, 14, 17, 19. | 0 53.7 |    | Lieut. S. W. Very, U. S. N.; Actg. Asst. Coast and Geodetic Survey. In vegetable garden of Fort Brady; in $\phi = 46^{\circ} 29' N.$ $\lambda = 84^{\circ} 20' W.$                                                                |
|    |                                |        |    | Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                                |
| 10 | 1880, August 6, 7.             | 1 04.5 | W. | J. B. Baylor, U. S. Coast and Geodetic Survey. In military post garden, about 30 meters N. W. of Lieut. Very's position of 1880. Reference as above. [Mean $\phi = 59'.1 W.$ —SCH.]                                               |

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## 3.—DULUTH, MINN., AND SUPERIOR CITY, WIS.

 $\phi = 46^{\circ} 45'.5$ ,  $\lambda = 92^{\circ} 04'.5$  W. of Gr.       $\phi = 46^{\circ} 39'.9$ ,  $\lambda = 92^{\circ} 04'.2$  W. of Gr.

|   |                      |            |                                                                                                                                                                                                                                      |
|---|----------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1824. 5.             | 12 30 E.   | Capt. Bayfield, at river St. Louis, near Fond du Lac; in $\phi = 46^{\circ} 43'$ , $\lambda = 92^{\circ} 10'$ W. Sir Edw. Sabine, in Phil. Trans. Roy. Soc., 1872, Cont'n xiii. [To reduce to Duluth subtract $10'$ ; not used—SCH.] |
| 1 | 1859, July.          | 9 25. 2    | Lieut. W. P. Smith, U. S. Survey of N. and N.W. Lakes; Capt. G. G. Meade, Detroit, 1859. At Minnesota Point, in $\phi = 45^{\circ} 46'$ , $\lambda = 92^{\circ} 14'$ W.                                                              |
| 2 | 1861. .              | 10 12      | U. S. Survey of N. and N.W. Lakes.                                                                                                                                                                                                   |
| 3 | 1870, September 20.  | 10 30      | Gen. C. B. Comstock, U. S. Lake Survey; at Superior City, in $\phi = 46^{\circ} 43'$ , $\lambda = 92^{\circ} 04'$ W. Gen. Comstock's letter of May 7, 1875.                                                                          |
| 4 | 1871, June 20, 27.   | 10 40      | Gen. C. B. Comstock; reference as before. In $\phi = 46^{\circ} 45'.4$ , $\lambda = 92^{\circ} 04'.5$ W. At North Base, Minnesota Point.                                                                                             |
|   | 1873, August 13, 15. | 11 51. 8   | Capt. A. N. Lee, U. S. E.; at Duluth; Report of Chief of Engineers, 1874, App. C C, and letter of Gen. Comstock as above. In $\phi = 46^{\circ} 45'.5$ , $\lambda = 92^{\circ} 04'.5$ W. [Not used.—SCH.]                            |
| 5 | 1880, August 21, 23. | 9 45. 4 E. | J. B. Baylor, U. S. Coast and Geodetic Survey; at Superior City, in $\phi = 46^{\circ} 40'$ , $\lambda = 92^{\circ} 04'$ W. Coast and Geodetic Survey Report for 1881, App. 9. [To this value double weight is given—SCH.]           |

## 4.—PIERREPONT MANOR, JEFFERSON COUNTY, N. Y.

 $\phi = 43^{\circ} 44'.5$        $\lambda = 76^{\circ} 03'.0$  W. of Gr. \*

|    |                             |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----|-----------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1823, September 18.         | 2 16. 1 W. | W. C. Pierrepont. Letter of Verplanck Colvin of May 5, 1871; also, report of the Adirondack State-land survey, 1886, Verplanck Colvin superintendent, Albany, 1886. [Compared with an observation at Lowville in 1821, viz, $4^{\circ} 30'$ W., the Pierrepont Manor value appears too small. A table of values in the Adirondack Survey Reports for 1884 and 1886, giving observed and interpolated declinations between 1797 and 1874, is very defective.† The weight $\frac{1}{3}$ is assigned to the 1823 observation—SCH.] |
| 2  | 1847, September 18.         | 4 23       | Letter of V. Colvin of May 5, 1871, and his reports of Adirondack Surveys of 1884, 1886.                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 3  | 1856, November 25.          | 5 10. 0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 4  | 1860, July 15, 16.          | 5 36       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 5  | 1863, July 10.              | 5 44       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 6  | 1864, April 12.             | 5 50       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 7  | 1865, { May } 4.            | 6 00       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|    | { June }                    |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 8  | 1866, September 11.         | 6 15       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 9  | 1867, July 27.              | 6 10       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 10 | 1868, May 12.               | 6 10       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 11 | 1869, May 11.               | 6 18       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 12 | 1870, May 27, September 21. | 6 03. 5 W. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

\* The geographical position here given depends on that of Mannsville as determined by the U. S. Lake Survey.

† The table gives zero declination for October 1, 1797. This mistake originally arose, I suppose, by confusing the annual change, which was then about zero, with the declination itself. Mr. Colvin himself points out elsewhere in his report of 1886 that the declination was *not* zero in the Adirondack region about that time, but reprints the table uncorrected.

## UNITED STATES COAST AND GEODETIC SURVEY.

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## 4.—PIERREPONT MANOR, JEFFERSON COUNTY, N. Y.—Continued.

|    |                   |           |                                                                                                                                                                                                                                                                             |
|----|-------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13 | 1874--            | 6 44 W.   | Letter of V. Colvin of May 5, 1871, and his reports of Adirondack Surveys of 1884, 1886.<br>Dr. T. C. Hilgard, Observer to U. S. Coast Survey. Station half a mile S.W. of village, stone in pasture on Pierrepont's meridian line. [Weighted value 6° 33' W. adopted—SCH.] |
|    | 1874, October 20. | 6 11.9 W. |                                                                                                                                                                                                                                                                             |

## 5.—TORONTO, ONTARIO, CANADA.

$$\phi = 43^{\circ} 39'.4 \quad \lambda = 79^{\circ} 23'.5 \text{ W. of Gr.}$$

(The Magnetic Observatory.)\*

|    |                                           |           |                                                                                                                                                                                                                               |
|----|-------------------------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1840, January.                            | 1 27 W.   | Capt. C. J. B. Riddell, R. A. Phil. Trans. Roy. Soc., 1849.<br>Vol. i, Toronto Mag'l and Met'l Observations, p. xi. Mean annual declinations. In the abstract of results, published in 1875, 1° 19'.1 W. is given for 1842.5. |
| 2  | 1841. 5.                                  | 1 14.3    |                                                                                                                                                                                                                               |
| 3  | 1842. 5.                                  | 1 18.9    |                                                                                                                                                                                                                               |
| 4  | 1845. 5.                                  | 1 29.1    | Vol. ii, Toronto Mag'l and Met'l Observations, pp. iii-v. Mean annual declinations.                                                                                                                                           |
| 5  | 1846. 5.                                  | 1 30.8    |                                                                                                                                                                                                                               |
| 6  | 1847. 5.                                  | 1 33.2    |                                                                                                                                                                                                                               |
| 7  | 1848. 5.                                  | 1 35.4    | These values are corrected for annual and secular variations.                                                                                                                                                                 |
| 8  | 1849. 5.                                  | 1 36.9    |                                                                                                                                                                                                                               |
| 9  | 1850. 5.                                  | 1 38.6    |                                                                                                                                                                                                                               |
| 10 | 1851. 5.                                  | 1 40.9    | Mean annual declinations.                                                                                                                                                                                                     |
| 11 | 1853, July and August.                    | 1 46.1    |                                                                                                                                                                                                                               |
| 12 | 1854, February, March, April, and June.   | 1 48.0    |                                                                                                                                                                                                                               |
| 13 | 1855, August to December, both inclusive. | 1 52.3    |                                                                                                                                                                                                                               |
| 14 | 1856. 5.                                  | 1 56.3    |                                                                                                                                                                                                                               |
| 15 | 1857. 5.                                  | 2 00.5    |                                                                                                                                                                                                                               |
| 16 | 1858. 5.                                  | 2 04.5    |                                                                                                                                                                                                                               |
| 17 | 1859. 5. †                                | 2 07.4    |                                                                                                                                                                                                                               |
| 18 | 1860. 5.                                  | 2 10.6    |                                                                                                                                                                                                                               |
| 19 | 1861. 5.                                  | 2 14.3    |                                                                                                                                                                                                                               |
| 20 | 1862. 5.                                  | 2 15.7    |                                                                                                                                                                                                                               |
| 21 | 1863. 5.                                  | 2 19.1    |                                                                                                                                                                                                                               |
| 22 | 1864. 5.                                  | 2 21.9    |                                                                                                                                                                                                                               |
| 23 | 1865. 5.                                  | 2 24.8    |                                                                                                                                                                                                                               |
| 24 | 1866. 5.                                  | 2 27.6    |                                                                                                                                                                                                                               |
| 25 | 1867. 5.                                  | 2 29.8    |                                                                                                                                                                                                                               |
| 26 | 1868. 5.                                  | 2 33.2 W. |                                                                                                                                                                                                                               |

\* For values in the above table prior to 1869, see also results published by G. T. Kingston, M. A., director of the Magnetic Observatory, Toronto, in the Canadian Journal, especially two communications, "Monthly absolute values of the magnetic elements at Toronto, from 1856 to 1864, inclusive," and "Monthly absolute values of the magnetic elements at Toronto, from 1865 to 1868, inclusive, with the annual means from 1841 to 1868." Director Kingston placed the observatory in  $\phi = 43^{\circ} 39'.4$ ,  $\lambda = 79^{\circ} 23'.3$  W.

† June 25-30, 1859, Lieut. W. P. Smith observed the declination  $2^{\circ} 11'.6$  W. Capt. G. G. Meade, U. S. Survey of the N. and W. Lakes, Detroit, 1859. [Not used—SCH.]

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## 5.—TORONTO, ONTARIO, CANADA—Continued.

|    |                   |            |                                                                                                                                                                                                                                                                                         |
|----|-------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                   | ° /        |                                                                                                                                                                                                                                                                                         |
| 27 | 1869. 5.          | 2 37. 1 W. | Abstracts and Results of magnetical and meteorological observations at the Magnetic Observatory, Toronto, Canada, from 1841 to 1871, inclusive. Toronto, 1875. Mean annual declinations.                                                                                                |
| 28 | 1870. 5.          | 2 41. 9    |                                                                                                                                                                                                                                                                                         |
| 29 | 1871. 5.          | 2 47. 9    |                                                                                                                                                                                                                                                                                         |
| 30 | 1872. 5.          | 2 53. 0    |                                                                                                                                                                                                                                                                                         |
| 31 | 1873. 5.          | 2 58. 3    |                                                                                                                                                                                                                                                                                         |
| 32 | 1874. 5.          | 3 04. 1    | Mean annual declinations communicated Feb. 28, 1881, by Mr. Chas. Carpmael, director of the Toronto Magnetic Observatory and Supt. of the Meteorological Service, Toronto, Ontario. [In a recent communication to the Supt. of the Naut. Alm. he gives the longitude 79° 23' 39''—SCH.] |
| 33 | 1875. 5.          | 3 11. 7    |                                                                                                                                                                                                                                                                                         |
| 34 | 1876. 5.          | 3 18. 5    |                                                                                                                                                                                                                                                                                         |
| 35 | 1877. 5.          | 3 24. 9    |                                                                                                                                                                                                                                                                                         |
| 36 | 1878. 5.          | 3 31. 4    |                                                                                                                                                                                                                                                                                         |
| 37 | 1879. 5.          | 3 37. 3    | Communicated by Mr. C. Carpmael, director of the observatory, Jan. 14, 1881.                                                                                                                                                                                                            |
| 38 | 1880, October 18. | 3 41. 1    |                                                                                                                                                                                                                                                                                         |
| 39 | 1884, August.     | 3 57. 2 W. | Communicated by Mr. Otto J. Klotz. Proceedings of the Association of Dominion Land Surveyors, Ottawa, 1885.                                                                                                                                                                             |

## 6.—GRAND HAVEN, MICH.

 $\phi = 43^{\circ} 05'.2$        $\lambda = 86^{\circ} 12'.6$  W. of Gr.

|   |                      |                          |                                                                                                                                                                                                     |
|---|----------------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |                      | °                        |                                                                                                                                                                                                     |
| 1 | 1825--               | 3 $\frac{3}{4}$ to 6° E. | L. Lyon; at Grand River in $\phi = 42^{\circ} 55'$ , $\lambda = 86^{\circ} 10'$ W. Prof. E. Loomis, Sill. Jour., vol. xxxix, 1840.                                                                  |
|   |                      | ° /                      |                                                                                                                                                                                                     |
| 2 | 1837--               | 4 30                     | Geological Report; reference as above. In $\phi = 42^{\circ} 55'$ , $\lambda = 86^{\circ} 10'$ W.                                                                                                   |
|   |                      | 6 15                     | Geological Report; reference as above. In $\phi = 43^{\circ} 19'$ , $\lambda = 85^{\circ} 59'$ W.                                                                                                   |
| 3 | 1859, August 18.     | 4 24. 2                  | Lieut. W. P. Smith, U. S. Survey of N. and N. W. Lakes; report by Capt. G. G. Meade, Detroit, 1859. In $\phi = 43^{\circ} 05'.2$ , $\lambda = 86^{\circ} 12'.6$ W.                                  |
| 4 | 1865--               | 4 15                     | U. S. Survey of N. and N. W. Lakes. MS. by Col. Reynolds, Dec., 1865. In $\phi = 43^{\circ} 04'$ , $\lambda = 86^{\circ} 13'$ W.                                                                    |
| 5 | 1873, August 28, 29. | 3 28. 2                  | Capt. A. N. Lee, U. S. Survey of N. and N. W. Lakes; MS. of 1873. See also Report of Chief of Engineers for 1874.                                                                                   |
| 6 | 1880, July 20, 21.   | 2 25. 7 E.               | J. B. Baylor, U. S. Coast and Geodetic Survey. In grounds of the county court-house, $\phi = 43^{\circ} 04'.7$ , $\lambda = 86^{\circ} 12'.6$ W. Coast and Geodetic Survey Report for 1881, App. 9. |

## MADISON, WIS.

 $\phi = 43^{\circ} 04'.6$        $\lambda = 89^{\circ} 24'.2$  W. of Gr.

(University of Wisconsin.)

|   |                   |         |                                                                                                                                                                                                                       |
|---|-------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |                   | ° /     |                                                                                                                                                                                                                       |
| 1 | 1839, November 2. | 7 30 E. | Dr. J. Locke; in survey of "Mineral Lands," Exec. Doc., 1839-40, vol. vi, 1839. In $\phi = 43^{\circ} 03'$ , $\lambda = 89^{\circ} 11'$ W.                                                                            |
| 2 | 1841, September.  | 7 30 E. | Dr. Locke and Prof. Loomis; southeast of the State-house (or capitol), in $\phi = 43^{\circ} 04'.5$ , $\lambda = 89^{\circ} 23'.0$ W. Phil. Trans. Roy. Soc., 1872. [The long. given, 89° 06', is much in error—SCH.] |

## UNITED STATES COAST AND GEODETIC SURVEY.

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## MADISON, WIS.—Continued.

|   |                                       |           |                                                                                                                                          |                                                                                                                                                                                                                                                                                                         |
|---|---------------------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1876, October 10, 11, 12, 13, 14.     | 6 59.7 E. | F. E. Hilgard, observer for U. S. Coast Survey; Coast and Geod'c Survey Rep. for 1881, App. 9. [Not used—SCH.]                           | Station near and south of University central building, in $\phi=43^{\circ} 04'.5$ , $\lambda=89^{\circ} 24'.2$ W. [This place was found affected by the erection of a watertank and of vertical pipes, hence a new station was established in 1878 on the University farm,* about 1 st. mile west—SCH.] |
|   | 1877, August 30, September 21.        | 6 44.9    | A. Braid, U. S. Coast Survey. Reference as above. [Not used—SCH.]                                                                        |                                                                                                                                                                                                                                                                                                         |
|   | 1878, August 29, 30.                  | 6 34.0    | Dr. Gustavus Hinrichs; in connection with magnetic survey of Iowa. MS. communication.                                                    |                                                                                                                                                                                                                                                                                                         |
| 3 | 1878, September 8, 9, 10, 11, 12, 13. | 6 31.8    | W. Suess, observer for U. S. Coast Survey; Coast and Geodetic Survey Report for 1881, App. 9.                                            |                                                                                                                                                                                                                                                                                                         |
|   | 1878, November 22, 23, 25.            | 6 22.9    | J. B. Baylor, U. S. Coast and Geod'c Survey. Reference as before. [Corrected for local attraction; weight assigned, $\frac{1}{2}$ —SCH.] |                                                                                                                                                                                                                                                                                                         |
| 4 | 1879, September 22 to October 11.     | 6 26.8    | David Mason, observer for Coast and Geod'c Survey. Station on University Hill, south of building.                                        |                                                                                                                                                                                                                                                                                                         |
| 5 | 1880, September 15 to 22.             | 6 20.9 E. | Observer, position, and reference as above.                                                                                              |                                                                                                                                                                                                                                                                                                         |

\* The observations on the University farm, in  $\phi=43^{\circ} 04'.5$ ,  $\lambda=89^{\circ} 25'.2$  W., gave the following results (see Coast and Geod'c Survey Report for 1881, App. 9):

|                                |           |                         |                                                                      |                          |
|--------------------------------|-----------|-------------------------|----------------------------------------------------------------------|--------------------------|
| 1878, November 13, 14, 15.     | 6 31.7 E. | J. B. Baylor, observer. | [Combining the two stations, the following mean values were adopted: | For 1878.8, 6 31.3 E.    |
| 1879, October 6, 7, 8, 9.      | 6 30.9    | David Mason, observer.  |                                                                      | 1879.7, 6 28.8           |
| 1880, September 23 to 28.      | 6 22.9    | David Mason, observer.  |                                                                      | 1880.7, 6 21.9           |
| 1881, December 16, 17, 18, 19. | 6 21.0 E. | W. Suess, observer.     |                                                                      | 1881.9, 6 19.8 E. —SCH.] |

[From the values collected at this station nothing further can be deduced than the average annual change, which was  $+3'.9$  between 1878 and 1882—SCH.]

## MILWAUKEE, WIS.

$\phi=43^{\circ} 03'$        $\lambda=87^{\circ} 56'$  W. of Gr.

|   |                  |           |                                                                                                                                                                      |
|---|------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1859, August 20. | 6 20.1 E. | Lieut. W. P. Smith, U. S. Survey of N. and N. W. Lakes; communicated by Capt. G. G. Meade, Detroit, 1859. In $\phi=43^{\circ} 02'.8$ , $\lambda=87^{\circ} 55'.1$ W. |
| 2 | 1873, August 22. | 6 22.4    | Capt. A. N. Lee, U. S. E.; survey of N. and N. W. Lakes, Gen'l C. B. Comstock in charge. MS. received in 1873. Position as above.                                    |
| 3 | 1878, May.       | 6 43 E.   | Major D. C. Houston, U. S. E.; Report of Chief of Engineers, 1878, part ii, p. 1166, map. [Observations insufficient for discussion—SCH.]                            |

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## 7.—BUFFALO, N. Y.

 $\phi = 42^{\circ} 52'.8$        $\lambda = 78^{\circ} 53'.5$  W. of Gr.

(Light-house in the harbor.)

|   |                             |        |    |                                                                                                                                                                                                   |
|---|-----------------------------|--------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1797--                      | 0 00   | W. | Amry Atwater, surveyor; east end of Lake Erie. MS. collection by Charles Whittlesey; communicated to the Coast Survey March 26, 1860.                                                             |
| 2 | 1798--                      | 0 30   |    | Buffalo reservation, lake shore. August Porter, in twenty-second report of Regents of University, New York, Albany, 1869.                                                                         |
| 3 | 1837--                      | 1 25   |    | R. W. Haskins, in $\phi = 42^{\circ} 53'$ , $\lambda = 78^{\circ} 55'$ W. Prof. E. Loomis' collection, Sill. Jour., vol. xxxiv, 1838.                                                             |
| 4 | 1839--                      | 1 15   |    | At Fort Erie, $\phi = 42^{\circ} 52'$ , $\lambda = 78^{\circ} 59'$ W. U. S. Lake Survey-chart.                                                                                                    |
| 5 | 1845--                      | 1 25   |    | Capt. J. H. Lefroy; Gen. Sir Edw. Sabine's Contribution xlii, in Phil. Trans. Roy. Soc., 1872.                                                                                                    |
| 6 | 1859, June.                 | 2 56.5 |    | Lieut. W. P. Smith; U. S. Lake Survey, in $\phi = 42^{\circ} 53'$ , $\lambda = 78^{\circ} 53'$ W., near south pier. Report of the U. S. Lake Survey, by Capt. G. G. Meade, Detroit, 1859, App. B. |
| 7 | 1872, June 14.              | 3 52.4 |    | Capt. A. N. Lee, U. S. Lake Survey, in $\phi = 42^{\circ} 53'$ , $\lambda = 78^{\circ} 54'$ W. Report of Chief of Engineers for 1873, magnetic results, 1870-73, pp. 1195-1197.                   |
| 8 | 1873, June 4 and 5.         | 3 58.3 |    | Observer, position, and reference as before.                                                                                                                                                      |
| 9 | 1885, September 17, 18, 19. | 5 04.3 | W. | J. B. Baylor, subasst. U. S. Coast and Geodetic Survey. At Fort Porter, $\phi = 42^{\circ} 55'$ , $\lambda = 78^{\circ} 54'$ W. MS. in Coast and Geodetic Survey archives.                        |

## 8.—DETROIT, MICH.

 $\phi = 42^{\circ} 20'.0$        $\lambda = 83^{\circ} 03'.0$  W. of Gr.

|     |                          |        |    |                                                                                                                                                                                                                                      |
|-----|--------------------------|--------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | 1810--                   | 2 48   | E. | J. Mansfield. Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838. Position assigned, $\phi = 42^{\circ} 30'$ , $\lambda = 82^{\circ} 58'$ W.                                                                               |
| 2   | 1822--                   | 3 13   |    | L. Lyons -----                                                                                                                                                                                                                       |
| 3   | 1828--                   | 2 50   |    | L. Lyons -----                                                                                                                                                                                                                       |
| 4   | 1835--                   | 2 10   |    | Geological Report -----                                                                                                                                                                                                              |
| 5 { | 1840--                   | 2 00   |    | Geological Report -----                                                                                                                                                                                                              |
|     | 1840--                   | 1 56   |    | Prof. E. Loomis; Gen. Sir Edw. Sabine, Phil. Trans. Roy. Soc., 1872, Contribution No. xlii.                                                                                                                                          |
| 6   | 1859, April.             | 0 42   |    | U. S. Lake Survey. MS. communicated by Col. W. F. Reynolds, U. S. E.                                                                                                                                                                 |
| 7   | 1865--                   | 0 40   |    | Position assigned, $\phi = 42^{\circ} 20'$ , $\lambda = 83^{\circ} 03'$ W.                                                                                                                                                           |
| 8   | 1872, May 8-29.          | 0 25.2 |    | Capt. A. N. Lee, U. S. A., observer; U. S. Lake Survey, Gen. C. B. Comstock Superintendent. Report of the Chief of Engineers for 1873, pp. 1195-1197. Position assigned, $\phi = 42^{\circ} 20'.0$ , $\lambda = 83^{\circ} 02'.5$ W. |
| 9   | 1873, May 5-17.          | 0 17.3 |    |                                                                                                                                                                                                                                      |
| 10  | 1876, June 3, 6.         | 0 04.7 | E. | Lieut. T. N. Bailey, observer; U. S. Lake Survey; Report of Chief of Engineers for 1877, vol. 2. Position assigned, $\phi = 42^{\circ} 20'$ , $\lambda = 83^{\circ} 03'.1$ W.                                                        |
| 11  | 1885, September 2, 3, 4. | 0 31.0 | W. | J. B. Baylor, subasst. U. S. Coast and Geodetic Survey. MS. in C. and G. S. archives. Rear of Harper Hospital. In $\phi = 42^{\circ} 21'.0$ , $\lambda = 83^{\circ} 03'.1$ W.                                                        |

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

9.—ERIE, PA.

 $\phi = 42^{\circ} 07'.8$        $\lambda = 80^{\circ} 05'.4$  W. of Gr.

(Court-house.)

|    |                             |        |    |                                                                                                                                                                                                                                                                                                                                                                                   |
|----|-----------------------------|--------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1786, October.              | 0 32   | W. | New York and Pennsylvania boundary line; monument on French Creek, in $\phi = 42^{\circ} 00'$ , $\lambda = 79^{\circ} 58'$ W., about 10 miles S.S.E. of Erie. Geological Survey of New York. See also map in the State Dept. of New York on which the observed variations are "protracted by Abm. Hardenberg, one of the Commissioners for the State of New York, Oct. 29, 1787." |
| 2  | 1793--                      | 0 42.2 | E. | Annual report of the Secretary for Internal Affairs, State of Pa., 1885; Harrisburg, 1886.                                                                                                                                                                                                                                                                                        |
| 3  | 1795--                      | 0 43   | E. | Andrew Ellicot; stone monument corner Parade and Front streets, in $\phi = 42^{\circ} 08'.2$ , $\lambda = 80^{\circ} 05'.2$ W. American Almanac of 1861, p. 54, Boston, 1861.                                                                                                                                                                                                     |
| 4  | 1841, August 9.             | 0 30   | W. | Dr. A. D. Bache, magnetic survey of Penn'a; Coast and Geodetic Survey Report for 1862, p. 213.                                                                                                                                                                                                                                                                                    |
| 5  | 1855--                      | 1 33   |    | Annual Report of the Secretary for Internal Affairs, State of Pennsylvania, for 1877; Harrisburg, 1878.                                                                                                                                                                                                                                                                           |
| 6  | 1859, April.                | 1 34   |    | Samuel Low; at meridian line established by him in cemetery. Mean of 9 years of observation, 1855 to 1863, inclusive. From Annual Report of Secretary for Internal Affairs, Commonwealth of Pennsylvania, Harrisburg, 1876, p. 20 A. In $\phi = 42^{\circ} 09'$ , $\lambda = 80^{\circ} 05'$ W.                                                                                   |
|    | 1859, June                  | 1 44.4 |    | Lieut. W. P. Smith, U. S. survey of N. and N. W. Lakes; Capt. G. G. Meade in charge. At Presque Isle Harbor, in $\phi = 42^{\circ} 09'.8$ , $\lambda = 80^{\circ} 05'.3$ W. [Mean of two values, $+ 1^{\circ} 39'.2$ .]                                                                                                                                                           |
| 7  | 1862, August 6, 7           | 1 33   |    | C. A. Schott, assistant Coast Survey. Same place as in Dr. Bache's survey, near Mr. Reed's house, 7th street, in $\phi = 42^{\circ} 07'.5$ , $\lambda = 80^{\circ} 05'.3$ W. Coast Survey Report for 1862, p. 212.                                                                                                                                                                |
|    | 1862--                      | 1 30   |    | Samuel Low, observer. Annual Report of Secretary for Internal Affairs of Pa., 1885; Harrisburg, 1886.                                                                                                                                                                                                                                                                             |
| 8  | 1867, April.                | 2 13   |    | Samuel Wilson; at meridian line in cemetery. Mean of 7 years of observation, 1864 to 1870, inclusive. Annual Rep. of Sec'y for Int. Aff. of Pa., 1876.                                                                                                                                                                                                                            |
| 9  | 1873, June 12, 13.          | 2 00.7 |    | Capt. A. N. Lee, U. S. Lake Survey. Report of Chief of Engineers for 1873, pp. 1195-1197; magnetic results 1870 to 1873. In $\phi = 42^{\circ} 08'.2$ , $\lambda = 80^{\circ} 05'.3$ W.                                                                                                                                                                                           |
|    | 1873, October.              | 2 36   |    | Samuel Wilson; at meridian line in cemetery. Mean of 6 years of observation, 1871 to 1876, inclusive. Annual Rep. of the Sec'y for Int. Aff. of Pa., 1876. [Mean, $+ 2^{\circ} 18'.3$ .]                                                                                                                                                                                          |
| 10 | 1876--                      | 2 50   |    | Annual Report of the Sec'y for Internal Affairs of Pa., 1876.                                                                                                                                                                                                                                                                                                                     |
| 11 | 1877, November.             | 3 00   |    | Annual Report of the Sec'y for Int. Aff. of Pa., 1877; Harrisburg, 1878.                                                                                                                                                                                                                                                                                                          |
| 12 | 1883, November 9.           | 3 20   |    | Platt, observer; Annual Rep. of the Sec'y for Internal Affairs of Pa., 1885; Harrisburg, 1886.                                                                                                                                                                                                                                                                                    |
| 13 | 1885, September 11, 12, 14. | 3 08.2 | W. | J. B. Baylor, subasst. Coast and Geodetic Survey. Marine Hospital, in $\phi = 42^{\circ} 09'$ , $\lambda = 80^{\circ} 05'$ W. MS. in archives of C. and G. S.                                                                                                                                                                                                                     |

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## 10.—CHICAGO, ILL.

 $\phi = 41^{\circ} 50'.0$        $\lambda = 87^{\circ} 36'.7$  W. of Gr.

(Observatory, Dearborn University.)

|   |                    |        |    |                                                                                                                                                                                       |
|---|--------------------|--------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1823..             | 6 12   | E. | Major Long's expedition; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838. Locality assigned $\phi = 42^{\circ} 00'$ , $\lambda = 87^{\circ} 40'$ W.                      |
| 2 | 1857, July 23.     | 5 46.1 |    | Lieut. Col. J. D. Graham; Pub. Doc. 35th Congress, 1st Sess., No. 42, 1858. In $\phi = 41^{\circ} 54'$ , $\lambda = 87^{\circ} 38'$ W.                                                |
| 3 | 1878, September 2. | 4 33.1 | E. | Dr. T. E. Thorpe; grounds of the Chicago University, position as in heading. Proc. Roy. Soc. No. 200, 1880. [From these data only a rough result for secular change can be had.—SCH.] |

## 11.—CLEVELAND, OHIO.

 $\phi = 41^{\circ} 30'.3$        $\lambda = 81^{\circ} 42'.0$  W. of Gr.

|    |                       |             |    |                                                                                                                                                                                                           |
|----|-----------------------|-------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1796, September.      | 2 0         | E. | Aug. Porter and Seth Pease; in $\phi = 41^{\circ} 30'$ , $\lambda = 81^{\circ} 40'$ W. MS. compilation by Charles Whittlesey. March, 1860. In Coast Survey Archives.                                      |
| 2  | 1830..                | 1 20        |    | Ahaz Merchant; Prof. E. Loomis' collection, Sill. Jour., vol. xxxix, 1840.                                                                                                                                |
| 3  | 1831, August.         | 1 15        |    | Edwin Foote; MS. compilation by C. Whittlesey, 1860.                                                                                                                                                      |
| 4  | 1834, winter.         | 0 50        |    | Ahaz Merchant; Prof. E. Loomis' collection, as above.                                                                                                                                                     |
| 5  | 1838, winter.         | 0 35        |    | Observer and reference as above.                                                                                                                                                                          |
| 6  | 1840..                | 0 19        |    | Prof. E. Loomis; Gen. Sabine in Phil. Trans. Roy. Soc. 1872, contribution xiii. (Misprinted $1^{\circ} 19'$ E.) See Dr. C. Davies on "Surveying."                                                         |
| 7  | 1841, May 1.          | 0 05.2      |    | J. N. Pillsbury. MS. compilation by C. Whittlesey, 1860.                                                                                                                                                  |
| 8  | 1845..                | 0 39        | E. | From a chart of survey of N. and N. W. Lakes, Top. Eng'rs. Beacon Light in $\phi = 41^{\circ} 31'$ , $\lambda = 81^{\circ} 41'.5$ W.                                                                      |
| 9  | 1859, July 5.         | 0 46        | W. | Lieut. W. P. Smith, Top. Eng'rs; in $\phi = 41^{\circ} 30'$ , $\lambda = 81^{\circ} 40'$ W. MS. by Ch. Whittlesey; also MS. by W. F. Reynolds, Major of Eng'rs, survey of N. and N. W. Lakes, Dec., 1865. |
|    | 1865..                | 1 12 E. (?) |    | MS. by W. F. Reynolds, Maj. of Eng'rs. [Value not used.—SCH.]                                                                                                                                             |
| 10 | 1871, November 9–11.  | 0 32.6      | W. | Edw. Goodfellow, asst. Coast Survey; at Marine Hospital in $\phi = 41^{\circ} 30'.4$ , $\lambda = 81^{\circ} 41'.5$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                                |
| 11 | 1872, June 17, 18.    | 0 44.9      |    | Capt. A. N. Lee, U. S. Lake Survey; Report of Chief of Eng'rs for 1873.                                                                                                                                   |
| 12 | 1873, June 16, 17.    | 0 50.9      |    | Observer and reference as above.                                                                                                                                                                          |
| 13 | 1880, July 9, 10, 12. | 1 38.5      | W. | J. B. Baylor, U. S. Coast and Geodetic Survey; station of 1871, grounds of the City Hospital.                                                                                                             |

## 12.—OMAHA, NEBR., AND COUNCIL BLUFFS, IOWA.

 $\phi = 41^{\circ} 15'.7$        $\lambda = 95^{\circ} 56'.5$  W. of Gr.

(Astron'l station, grounds of High School, Omaha.)

|   |                     |         |    |                                                                                                                                                                                                                                                               |
|---|---------------------|---------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1819, September 22. | 12 58.8 | E. | Major Steph. H. Long, U. S. A.; Expedition to the Rocky Mts., Philadelphia, 1823 (2 volumes). At Engineers' cantonment in $\phi = 41^{\circ} 25'$ , $\lambda = 96^{\circ} 00'$ W. [Reduction to Omaha, about $-12'$ , hence decl'n, $12^{\circ} 47'$ E.—SCH.] |
|---|---------------------|---------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## UNITED STATES COAST AND GEODETIC SURVEY.

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## 12.—OMAHA, NEBR., AND COUNCIL BLUFFS, IOWA—Continued.

|   |                                            |                   |                                                                                                                                                           |
|---|--------------------------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 | 1869, January 25-27.<br>February 12, 13. } | ° /<br>10 42.6 E. | Edw. Goodfellow, asst. Coast Survey; at astron'l station, Omaha; Coast and Geodetic Survey Report for 1881, App. 9.                                       |
| 3 | 1872, October 31.                          | 10 44.2           | Dr. T. C. Hilgard, Bache-Fund observer to National Academy; station as before (1869); Coast and Geodetic Survey Report for 1882, App. 14.                 |
| 4 | 1877, October 13-18.                       | 10 22.0           | A. Braid, U. S. Coast Survey; station of 1869; Coast and Geodetic Survey Report for 1881, App. 9.                                                         |
| 5 | 1878, August 30.                           | 10 39.7           | Dr. T. E. Thorpe; at Council Bluffs, near railway depot in $\phi = 41^{\circ} 15'.2$ , $\lambda = 95^{\circ} 52'.4$ W.; Proc. Roy. Soc. No. 200, 1880.    |
| 6 | 1880, October 15, 17.                      | 10 06.2 E.        | J. B. Baylor, Coast and Geodetic Survey. Station on grounds of High School as in 1869, 1872, and 1877; Coast and Geodetic Survey Report for 1881, App. 9. |

## 13.—PITTSBURGH, PA.

 $\phi = 40^{\circ} 27'.6$        $\lambda = 80^{\circ} 00'.8$  W. of Gr.

(Allegheny Observatory, Allegheny.)

|   |                          |                |                                                                                                                                           |
|---|--------------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1840, August 10.         | ° /<br>0 08 W. | Dr. A. D. Bache; at Homewood, in $\phi = 40^{\circ} 28'$ , $\lambda = 79^{\circ} 59'.5$ W.; Coast Survey Report for 1862, App. 19.        |
| 2 | 1845, May 3.             | 0 33.1         | Dr. John Locke, in $\phi = 40^{\circ} 26'$ , $\lambda = 79^{\circ} 58'$ W.; Coast Survey Report for 1855, p. 304.                         |
| 3 | 1878, September 5.       | 2 21.6         | Dr. T. E. Thorpe; at Allegheny, grounds of the astron'l observatory, latitude and longitude as in heading. Proc. Roy. Soc. No. 200, 1880. |
| 4 | 1884, September 26.      | 2 41           | Hemmings; Annual Report of the Secretary for Internal Affairs of Pa. for 1885, Harrisburg, 1886, p. 16 A, p. 31 A.                        |
| 5 | 1885, August 24, 25, 26. | 2 55.7 W.      | J. B. Baylor, subasst. Coast and Geodetic Survey; at Allegheny, grounds of the Observatory. MS. in archives of Survey.                    |

## DENVER, COLO.

 $\phi = 39^{\circ} 45'.3$        $\lambda = 104^{\circ} 59'.5$  W. of Gr.

(Coast Survey Astron'l Station.)

|   |                           |                |                                                                                                                                                                                                                                                                                                                                   |
|---|---------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1866, July.               | ° /<br>15 0 E. | John Prince, Surveyor-General of Colorado; in $\phi = 39^{\circ} 45'.3$ , $\lambda = 105^{\circ} 00'$ W. Letter to Office, of July 27, 1866.                                                                                                                                                                                      |
| 2 | 1872, October 13, 14, 19. | 14 44.7        | Dr. T. C. Hilgard, Bache-Fund observer to National Academy; on Pierce's Block; Coast and Geodetic Survey Report for 1882, App. 14.                                                                                                                                                                                                |
| 3 | 1873, August 14.          | 14 42.8        | Edw. Smith, asst. Coast Survey; at astron'l station, in $\phi = 39^{\circ} 45'.3$ , $\lambda = 104^{\circ} 59'.5$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                          |
| 4 | 1878, August 8.           | 14 43.4        | Dr. T. E. Thorpe; in Mrs. Craig's garden, $\phi = 39^{\circ} 45'.3$ , $\lambda = 104^{\circ} 59'.6$ W.; Proc. Roy. Soc. No. 200, 1880.                                                                                                                                                                                            |
|   | 1878, September 3, 4, 5.  | 14 40.2 E.     | J. B. Baylor, U. S. Coast Survey; corner of 17th st. and Broadway. Position as in heading; Coast and Geodetic Survey Report for 1881, App. 9. [Mean, — $14^{\circ} 41'.8$ for 1878.6.]<br>[From the values collected at this station we can only deduce the average annual change between 1866 and 1878, which is + $1'.6$ —SCH.] |

GROUP II.—*Series of Magnetic Stations, etc.—Continued.*

## 14.—MARIETTA, OHIO.

 $\phi = 39^{\circ} 25'$        $\lambda = 81^{\circ} 28'$  W. of Gr.

|   |                   |           |                                                                                                                                                                                                                     |
|---|-------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1810..            | 2 36 E.   | Jared Mansfield; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                                                                                                                                      |
| 2 | 1823-24.          | 3 30      | Boye; at Parkersburg, W. Va., in $\phi = 39^{\circ} 16'$ , $\lambda = 81^{\circ} 34'$ W. Boye's State map of Va. [Reduction to Marietta about + 5', hence decl'n = $-3^{\circ} 25'$ —SCH.]                          |
| 3 | 1838..            | 1 29      | Prof. E. Loomis; reference as above, in $\phi = 39^{\circ} 25'$ , $\lambda = 81^{\circ} 26'$ W.                                                                                                                     |
|   | 1838..            | 1 36      | B. E. Stone; near Marietta, in $\phi = 39^{\circ} 31'$ , $\lambda = 81^{\circ} 26'$ W. Prof. E. Loomis' collection in Sill. Jour., vol. xxxix, 1840. [The weight $\frac{1}{2}$ is assigned to the mean value.—SCH.] |
| 4 | 1845, April.      | 2 25      | Henk's Field-book.                                                                                                                                                                                                  |
| 5 | 1850..            | 1 25      | A. D. Bache's table in Gillespie's Treatise on Land Surveying.                                                                                                                                                      |
| 6 | 1864, January 26. | 1 17.6 E. | A. T. Mosman, asst. Coast Survey; at Parkersburg, W. Va., in $\phi = 39^{\circ} 16'.0$ , $\lambda = 81^{\circ} 34'.2$ W.; Coast and Geodetic Survey Report for 1881, App. 9. [Red'n to Marietta about + 5'—SCH.]    |
| 7 | 1881, May 30, 31. | 0 07.2 W. | J. B. Baylor, Coast and Geodetic Survey; at Parkersburg, station of 1864; reference as before. [Red'n to Marietta about + 5'—SCH.]                                                                                  |

## 15.—CINCINNATI, OHIO.

 $\phi = 39^{\circ} 06'.4$        $\lambda = 84^{\circ} 29'.8$  W. of Gr. $\phi = 39^{\circ} 08'.6$        $\lambda = 84^{\circ} 25'.3$  W. of Gr.

Old Astronomical Observatory on Mt. Adams.

New Astronomical Observatory on Mt. Lookout.

|   |                            |           |                                                                                                                                                        |
|---|----------------------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1806..                     | 4 58 E.   | Public surveys; Prof. E. Loomis' collection in Sill. Jour., vol. xxxix, 1840, in $\phi = 39^{\circ} 06'$ , $\lambda = 84^{\circ} 27'$ W.               |
| 2 | 1810..                     | 5 00      | Jared Mansfield; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838, in $\phi = 39^{\circ} 07'$ , $\lambda = 84^{\circ} 27'$ W.              |
| 3 | 1840, January 11.          | 4 46      | Dr. John Locke; "Survey of Mineral Lands," Exec. Doc., 1839-40, vol. vi; in $\phi = 39^{\circ} 06'$ , $\lambda = 84^{\circ} 27'$ W.                    |
| 4 | 1845, April.               | 4 04      | Dr. John Locke; Coast Survey Report for 1855, p. 304; in $\phi = 39^{\circ} 06'$ , $\lambda = 84^{\circ} 22'$ W.                                       |
| 5 | 1880, November 27, 29, 30. | 2 14.4 E. | J. B. Baylor, U. S. Coast and Geod. Survey; grounds of new astronomical observatory on Mt. Lookout; Coast and Geodetic Survey Report for 1881, App. 9. |

## 16.—ST. LOUIS, MO.

 $\phi = 38^{\circ} 38'.0$        $\lambda = 90^{\circ} 12'.2$  W. of Gr.

(Washington University.)

|   |                |            |                                                                                                                                                                                                                                                              |
|---|----------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1819, June 17. | 10 47.6 E. | Maj. S. H. Long; at St. Louis, in $\phi = 38^{\circ} 36'$ , $\lambda = 90^{\circ} 06'$ W. [Longitude as given, about 5' too small.—SCH.] Account of an expedition from Pittsburg to the Rocky Mts. in 1819 and 1820, by Maj. S. H. Long, Philadelphia, 1823. |
| 2 | 1835..         | 8 49       | Colonel Nicolls; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                                                                                                                                                                               |
| 3 | 1838..         | 7 45       | De Ward, surveyor; on city commons. Letter of Thos. Featherston, of June 18, 1877; communicated by W. Eimbeck, asst. Coast Survey.                                                                                                                           |
| 4 | 1855..         | 8 00       | Colton's General Atlas, New York, 1873.                                                                                                                                                                                                                      |

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

16.—ST. LOUIS, MO.—Continued.

|    |                               |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----|-------------------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5  | 1856, October 31.             | ° /<br>6 23.1 E. | Karl Friesach; Berichte der Kais. Akad. der Wiss., Vienna, vol. xxix, 1858.<br>Dr. T. C. Hilgard, Bache-Fund observer to National Academy. Two stations, south and west of court-house; first on Compton Hill, in $\phi = 38^{\circ} 37'.1$ , $\lambda = 90^{\circ} 14'.0$ W., decl'n $6^{\circ} 35'.2$ E., and second near City Hospital, in $\phi = 38^{\circ} 36'.5$ , $\lambda = 90^{\circ} 12'.7$ W., decl'n $6^{\circ} 39'.9$ E. Coast and Geodetic Survey Report for 1882, App. 14. [Result at a third station, $6^{\circ} 48'.9$ E., in field adjoining first position, not used.—SCH.] |
| 6  | 1872, June, July, and August. | 6 37.5           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 7  | 1877, June.                   | 6 30.5           | Thomas Featherson, deputy county surveyor St. Louis Co.; from comparisons of 17 old lines run in the city commons in 1838 by De Ward, surveyor; communicated by W. Eimbeck, asst. Coast Survey; annual change since 1838 supposed to have been $+ 1'.91$                                                                                                                                                                                                                                                                                                                                        |
| 8  | 1878, August 14, 15.          | 6 33.7           | Prof. F. E. Nipher, Washington University. Observations in vacant square, S. E. corner of Garrison ave. and Dickson street; Trans. St. Louis Acad. of Sciences. [The instrument was loaned by the Coast Survey.—SCH.]                                                                                                                                                                                                                                                                                                                                                                           |
| 9  | 1879, September.              | 6 13.3           | Observer as before; at corner of Garrison ave. and Glasgow place; communicated to office Oct. 14, 1879.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 10 | 1886, October 3, 4, 5, 6.     | 6 10.6 E.        | C. H. Sinclair, asst. Coast and Geodetic Survey; near N. W. corner of Tower Grove Park, St. Louis, in $\phi = 38^{\circ} 36'.7$ , $\lambda = 90^{\circ} 15'.4$ W.; MS. in archives of Survey.                                                                                                                                                                                                                                                                                                                                                                                                   |

## NASHVILLE, TENN.

 $\phi = 36^{\circ} 10'.0$        $\lambda = 86^{\circ} 47'.0$  W. of Gr.

|   |                         |                |                                                                                                                                                                                                                                                                                             |
|---|-------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1829--                  | ° /<br>6 50 E. | Prof. Hamilton; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838, in $\phi = 36^{\circ} 10'$ , $\lambda = 86^{\circ} 49'$ W.                                                                                                                                                    |
| 2 | 1835--                  | 7 07           | Prof. Hamilton; reference as above.                                                                                                                                                                                                                                                         |
| 3 | 1877, December 5, 6, 7. | 5 14.9 E.      | And. Braid, U. S. Coast Survey; grounds of Vanderbilt University, in $\phi = 36^{\circ} 09'.7$ , $\lambda = 86^{\circ} 47'.6$ W.; Coast and Geodetic Survey Report for 1881, App. 9.<br>[The above values are insufficient to give satisfactory information as to the secular change.—SCH.] |

## 17.—FLORENCE, ALA.

 $\phi = 34^{\circ} 47'.2$        $\lambda = 87^{\circ} 41'.5$  W. of Gr.

(Coast Survey Station.)

|   |                       |                |                                                                                                                                                                                         |
|---|-----------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1818--                | ° /<br>6 35 E. | J. H. Weakly; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838; position assigned $\phi = 34^{\circ} 50'$ , $\lambda = 87^{\circ} 47'$ W.                                   |
| 2 | 1835--                | 6 28           | Observer and reference as before.                                                                                                                                                       |
| 3 | 1865, April 17.       | 5 24           | A. T. Mosman, asst. Coast Survey; Coast and Geodetic Survey Report for 1881, App. 9, in $\phi = 34^{\circ} 47'.2$ , $\lambda = 87^{\circ} 41'.7$ W., near railway bridge.               |
| 4 | 1875, May 29.         | 5 14.4         | F. E. Hilgard, Bache-Fund observer to National Acad.; in $\phi = 34^{\circ} 47'$ , $\lambda = 87^{\circ} 42'$ W.; Coast and Geodetic Survey Report for 1882, App. 14.                   |
| 5 | 1881, September 5, 6. | 4 37.8 E.      | J. B. Baylor; Coast and Geodetic Survey; grounds of College for Females, in $\phi = 34^{\circ} 47'$ , $\lambda = 87^{\circ} 43'$ W.; Coast and Geodetic Survey Report for 1881, App. 9. |

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## NATCHEZ, MISS.

 $\phi = 31^{\circ} 33'.5$        $\lambda = 91^{\circ} 24'.0$  W. of Gr.

(Coast Survey Astronomical Station.)

|   |                     |         |                                                                                                                                                                                                               |
|---|---------------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1802--              | 9 0 E.  | Dunbar; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838; in $\phi = 31^{\circ} 34'$ , $\lambda = 91^{\circ} 25'$ W.                                                                              |
| 2 | 1872, April 21, 22. | 7 14.8  | Dr. T. C. Hilgard, Bache Fund observer to National Acad.; in $\phi = 31^{\circ} 34'$ , $\lambda = 91^{\circ} 24'$ W.; Coast and Geodetic Survey Report for 1882, App. 14.                                     |
| 3 | 1878-'79.           | 7 23 E. | W. H. Dennis, asst. Coast Survey; in $\phi = 31^{\circ} 33'.5$ , $\lambda = 91^{\circ} 24'.1$ W. Marked on MS. triangulation sketch.<br>[No satisfactory result can be had from these few observations.—SCH.] |

## 18.—MOBILE, ALA.

 $\phi = 30^{\circ} 41'.4$        $\lambda = 88^{\circ} 02'.5$  W. of Gr.

(Episcopal Church.)

|   |                       |         |                                                                                                                                                                                                                             |
|---|-----------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1809--                | 8 10 E. | J. H. Weakly; in $\phi = 30^{\circ} 40'$ , $\lambda = 88^{\circ} 11'$ W.; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838. [Not used.—SCH.]                                                                    |
| 1 | 1814--                | 6 30    | Kent; Encycl. Britan., 7th edition, 1842. For Mobile Bay; in $\phi = 30^{\circ} 13'$ , $\lambda = 88^{\circ} 21'$ W. [Longitude defective.—SCH.]                                                                            |
| 2 | 1835--                | 7 12    | J. H. Weakly; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                                                                                                                                                 |
| 3 | 1840--                | 7 05    | Chart of Mobile Bay by E. and G. W. Blunt; Coast Survey Report for 1845, p. 42.                                                                                                                                             |
| 4 | 1843--                | 6 56    | Commander L. M. Powell, U. S. N. (in an official report). At Mobile Pt. Light, $\phi = 30^{\circ} 13'.8$ , $\lambda = 88^{\circ} 01'.5$ W.; Coast Survey Report for 1855, p. 323. [Reduction to Mobile inappreciable.—SCH.] |
| 5 | 1847, May 21-30.      | 7 04.1  | R. H. Fauntleroy, asst. Coast Survey; at Fort Morgan, in $\phi = 30^{\circ} 13'.9$ , $\lambda = 88^{\circ} 01'.2$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                                                    |
| 6 | 1857, February 14-18. | 6 52.2  | Edw. Goodfellow, asst. Coast Survey; at Mobile City, near Episcopal Church, in $\phi = 30^{\circ} 41'.6$ , $\lambda = 88^{\circ} 02'.6$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                              |
| 7 | 1875, May 27.         | 6 07.0  | J. M. Poole, Bache-Fund observer to National Academy; in part of city known as Summerville, in $\phi = 30^{\circ} 42'$ , $\lambda = 88^{\circ} 03'$ W.; Coast and Geodetic Survey Report for 1882, App. 14.                 |
| 8 | 1883, March 12.       | 5 17 E. | Lieut. E. S. Prime, U. S. S. Yantic; in $\phi = 30^{\circ} 08'$ , $\lambda = 88^{\circ} 01'$ W.; Naval Professional Papers No. 19, Washington, 1886. [Reduction to Mobile inappreciable.—SCH.]                              |

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## 19.—NEW ORLEANS, LA.

 $\phi = 29^{\circ} 57'.2$        $\lambda = 90^{\circ} 03'.9$  W. of Gr.

(Custom House.)

|    |                       |   |         |                                                                                                                                                                                                                                                                                                                                                                                                              |
|----|-----------------------|---|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1720--                | 2 | E.      | Father Laval; Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838. [To this value the weight $\frac{1}{2}$ is given.—SCH.]                                                                                                                                                                                                                                                                          |
| 2  | 1768--                | 7 | 50      | Gauld; Gauld's survey of the Delta, near Pass à l'Outre. [Reduction to New Orleans, add 10'—SCH.]                                                                                                                                                                                                                                                                                                            |
| 3  | 1796--                | 5 | 06      | A. G. Blanchard, city surveyor; change from 1796 to 1870, 2° east.                                                                                                                                                                                                                                                                                                                                           |
| 4  | 1806--                | 8 | 03      | Lason; from 372 observations. Prof. E. Loomis' collection in Sill. Jour., vol. xxxiv, 1838.                                                                                                                                                                                                                                                                                                                  |
| 5  | 1840--                | 8 | 20      | From information recorded in General Land Office.                                                                                                                                                                                                                                                                                                                                                            |
| 6  | 1856, December 28.    | 8 | 00      | Karl Friesach; Berichte der Kais. Akad. der Wiss., Vienna, vol. xxix, 1858.                                                                                                                                                                                                                                                                                                                                  |
| 7  | 1858, April 6, 7.     | 7 | 51.5    | G. W. Dean, asst. Coast Survey; near Canal and Basin sts., in $\phi = 29^{\circ} 57'.4$ , $\lambda = 90^{\circ} 04'.4$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                                                                                |
| 8  | 1870--                | 7 | 06      | M. J. Thompson, State engineer.                                                                                                                                                                                                                                                                                                                                                                              |
| 9  | 1872, February 10-15. | 6 | 39.6    | Dr. T. C. Hilgard, Bache-Fund observer to National Academy; observations at City Park, $6^{\circ} 39'.8$ E.; at Fair Grounds, $6^{\circ} 39'.5$ E. Position of City Park, in $\phi = 29^{\circ} 55'.6$ , $\lambda = 90^{\circ} 07'.8$ W.; position of Fair Grounds, in $\phi = 29^{\circ} 59'.1$ , $\lambda = 90^{\circ} 04'.8$ W. Coast and Geodetic Survey Report for 1881, App. 9, and for 1882, App. 14. |
| 10 | 1880, March 24, 25.   | 6 | 27.6 E. | J. B. Baylor, U. S. Coast and Geodetic Survey; at Fair Grounds; Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                                                                                                                                           |

## 20.—SAN ANTONIO, TEX.

 $\phi = 29^{\circ} 25'.4$        $\lambda = 98^{\circ} 29'.3$  W. of Gr.

(Arsenal Grounds.)

|   |                        |    |         |                                                                                                                                               |
|---|------------------------|----|---------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1825--                 | 10 | 30 E.   | Land Office record at San Antonio; communicated by Mr. J. B. Baylor.                                                                          |
| 2 | 1836--                 | 9  | 45      |                                                                                                                                               |
| 3 | 1874--                 | 9  | 30      |                                                                                                                                               |
| 4 | 1878, June 10, 11, 12. | 9  | 22.3 E. | J. B. Baylor, U. S. Coast and Geodetic Survey; in Arsenal Grounds; position as in heading; Coast and Geodetic Survey Report for 1881, App. 9. |

## 21.—KEY WEST, FLA.

 $\phi = 24^{\circ} 33'.5$        $\lambda = 81^{\circ} 48'.5$  W. of Gr.

(Tift's Observatory.)

|   |                     |   |         |                                                                                                                                                                                                                          |
|---|---------------------|---|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1700.0.             | 5 | E.      | Edm. Halley's isogonic chart or Tabula Nautica Variationum Magneticarum Index, &c., anno 1700, reproduced in Greenwich observations for 1869. [Probably 1° in error; see values for Havana and Kingston; not used.—SCH.] |
| 1 | 1829, February.     | 6 | 25      | W. A. Whitehead; from a map of Florida by the Topographical Engineers, 1846.                                                                                                                                             |
| 2 | 1843--              | 6 | 02      | Report of Commander L. M. Powell, U. S. N.; at Custom-House.                                                                                                                                                             |
| 3 | 1849, August 19-21. | 5 | 28.8 E. | J. E. Hilgard, asst. Coast Survey; at Sand Key, in $\phi = 24^{\circ} 27'.2$ , $\lambda = 81^{\circ} 53'.1$ W.; Coast Survey Report for 1854, p. 145.                                                                    |

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## 21.—KEY WEST, FLA.—Continued.

|    |                                            |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----|--------------------------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4  | 1860, February, March, June, and December. | 4 46.6 E. | Prof. W. P. Trowbridge, asst. Coast Survey; at magnetic observatory, in $\phi = 24^{\circ} 33'.1$ , $\lambda = 81^{\circ} 48'.5$ W. W. P. Trowbridge and S. Walker, observers. Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                                                                                                                                                                                                                          |
| 5  | 1861, February, March, and April.          | 4 44.5    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 6  | 1862, May to December, inclusive.          | 4 39.9    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 7  | 1863, January to December, inclusive.      | 4 36.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 8  | 1864, January to December, inclusive.      | 4 33.9    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 9  | 1865, January to December, inclusive.      | 4 31.5    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 10 | 1866, January to April, inclusive.         | 4 29.8    | S. Walker, observer; at magnetic observatory. Means of monthly results and corrected for diurnal variation. In 1861, the observers were S. Walker and J. G. Oltmanns; in 1862, Walker, Oltmanns, and F. F. Ness; reference as before.                                                                                                                                                                                                                                                                                                                                                                      |
| 11 | 1879, March 24, 25, 26.                    | 3 33.9    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 12 | 1884, April 4.                             | 3 00      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|    | 1884, May 10.                              | 2 49 E.   | Lieut. S. M. Ackley, U. S. N., asst. Coast and Geod'c Survey; grounds of Army Hospital, in $\phi = 24^{\circ} 33'.3$ , $\lambda = 81^{\circ} 47'.9$ W.; Coast and Geodetic Survey Report for 1881, App. 9.<br>Lieut. C. Belknap, U. S. S. Vandalia; in $\phi = 24^{\circ} 27'$ , $\lambda = 81^{\circ} 48'$ W.; Naval Professional Papers No. 19, Washington, 1886. [Red'n to Key West inappreciable.—SCH.]<br>Lieut. R. B. Peck, U. S. S. Swatara; in $\phi = 24^{\circ} 25'$ , $\lambda = 81^{\circ} 46'$ W.; reference as before. [Reduction to Key West inappreciable; mean, $-2^{\circ} 54'.5$ —SCH.] |

## 22.—HAVANA, CUBA.

 $\phi = 23^{\circ} 09'.3$        $\lambda = 82^{\circ} 21'.5$  W. of Gr.

(Morro Light.)

|   |                        |      |    |                                                                                                                                                                                                      |
|---|------------------------|------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1700. O.               | 6    | E. | Edm. Halley's isogonic chart for 1700; reproduced in Greenwich observations for 1869. [Not used.—SCH.]                                                                                               |
| 1 | 1726--                 | 4 24 |    | Mathews; in $\phi = 23^{\circ} 02'$ , $\lambda = 81^{\circ} 44'$ W.; Encycl. Britan., 1848. [Rough reduction to Havana $+10'$ ; hence $4^{\circ} 34'$ E.—SCH.]                                       |
| 2 | 1732, March and April. | 4 30 |    | J. Harris; off Havana, in $\phi = 23^{\circ} 08'$ , $\lambda = 82^{\circ} 32'$ W.; Phil. Trans. Roy. Soc., vol. vii (abridged), 1724-34; also, Encycl. Metrop., 1848.                                |
| 3 | 1815--                 | 7 00 |    | Encycl. Brit., 7th edition, 1842.                                                                                                                                                                    |
| 4 | 1816, August.          | 5 30 |    | Bentley; reference as before.                                                                                                                                                                        |
| 5 | 1833. O.               | 6 50 |    | Peter Barlow's isogonic chart for 1833; Phil. Trans. Roy. Soc., 1833, p. I. [Supposed to be about $1^{\circ}$ too great; see Key West and Kingston series; used temporarily $5^{\circ} 50'$ E.—SCH.] |
| 6 | 1857, January 28.      | 5 15 |    | Karl Friesach; Imp. Acad. of Sc., Vienna, vol. xxix, 1858.                                                                                                                                           |
| 7 | 1858--                 | 5 45 | E. | From a map of Cuba, 1860.                                                                                                                                                                            |

TABLE 2.—*Continued*

MAGNETIC OBSERVATIONS.

|                                       |        |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------|--------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1843, March 16.                       | 3 52.3 | E. | Declination at Port Royal, Jamaica, according to the College de Besen. [Annual change at the College de Besen, according to Gauss 2 <sup>d</sup> ed. 1837, longitude of Observatory 4° 5', according to Gauss 2 <sup>d</sup> ed. 1837, longitude of Observatory of Munich 10° 15'. The position of the College de Besen is given as being, as that determined by Lieut. Comdr. J. R. Peck, U. S. S. Swatara, in 1858, and that of the College de Besen is according to Gauss 2 <sup>d</sup> ed. 1837, in $\phi = 27^{\circ} 20' N$ , $\lambda = 12^{\circ} 15' W$ .—SCH.] |
| 1844, 1845.                           | 3 36   | E. | Declination at Port Royal, Jamaica, in $\phi = 17^{\circ} 55' N$ , $\lambda = 76^{\circ} 48' W$ . Naval Professional Papers, No. 19, Washington, 1886. [Reduced to Havana 27° 44' N. Double weight is temporarily assigned to this value.—SCH.]                                                                                                                                                                                                                                                                                                                           |
| 2. KEY, JAMAICA, PORT ROYAL, JAMAICA. |        |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 1845, 1846.                           | 3 55.5 | E. | Declination at Port Royal, Jamaica, in $\phi = 17^{\circ} 55' N$ , $\lambda = 76^{\circ} 48' W$ . Naval Professional Papers, No. 19, Washington, 1886. [Reduced to Havana 27° 44' N. Double weight is temporarily assigned to this value.—SCH.]                                                                                                                                                                                                                                                                                                                           |
| 3. KEY, JAMAICA, PORT ROYAL, JAMAICA. |        |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 1846.                                 | 6 30   | E. | Declination at Port Royal, Jamaica according to J. R. Peck's: Phil. Trans. Roy. Soc., 1858. [Not used.—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 1846.                                 | 6 30   |    | According to Mountain's chart constructed in the year 1700 from Dr. Halley's tables; Long's History of Jamaica. [Halley's Tabula Nautica gives 7° E. for 1700. Not used.—SCH.]                                                                                                                                                                                                                                                                                                                                                                                            |
| 1846, March and April.                | 6 02.5 |    | J. Harris, at Black River; Phil. Trans. Roy. Soc., 1733. [Mean value of 6° and 6° 5' E. Weight 1/2 assigned to this value.—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1846 to 1847.                         | 6 50   |    | J. Leary; Chart of Port Royal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1846 to 1847.                         | 6 45   |    | J. Leary; Chart of Port Royal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1846.                                 | 6 30   |    | J. Robertson; Phil. Trans. Roy. Soc., 1806. The variation in Jamaica said to have been constant for 130 or 140 years.                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1846.                                 | 4 50   |    | De Meckau; in $\phi = 17^{\circ} 55' N$ , $\lambda = 76^{\circ} 09' W$ . } Becquerel's Traité du Magnétisme, Paris, 1846.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 1846.                                 | 4 50   |    | De Mayne; in $\phi = 17^{\circ} 55' N$ , $\lambda = 76^{\circ} 53' W$ . } netisme, Paris, 1846.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 1846.                                 | 4 54   |    | Owen; Becquerel as above.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 1846.                                 | 5 13   |    | Foster; Becquerel as above.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 1846 (1).                             | 4 40   |    | From a map of Kingston, date of 1854.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1846 (2).                             | 6 30   |    | Peter Barlow's isogonic chart for 1833; Phil. Trans. Roy. Soc., 1833. [Not used; value supposed to be about 1° too great; see Havana and Key West series.—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                           |
| 1847, October.                        | 4 18   |    | Milne; in $\phi = 17^{\circ} 56' N$ , $\lambda = 76^{\circ} 51' W$ . Lieut. Col. Edw. Sabine's contributions to Terr. Mag. No. ix; Phil. Trans. Roy. Soc., 1849, part II.                                                                                                                                                                                                                                                                                                                                                                                                 |
| 1847, April.                          | 3 40   |    | Barnet; in $\phi = 17^{\circ} 56' N$ , $\lambda = 76^{\circ} 51' W$ ; reference as before.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 1847, March 2.                        | 3 40   |    | Karl Freisach; Imp. Acad. of Sci., Vienna, vol. xxix, 1858.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 1866.                                 | 4 57   |    | British Admiralty Chart of Jamaica, No. 446; variation in 1866, nearly stationary. [Not used.—SCH.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 1875.                                 | 4 00   |    | British Admiralty Chart, No. 456; Port Royal and Kingston Harbor; annual decrease 2'.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1876.                                 | 3 35   |    | Brit. Admiralty Chart, No. 762; West India Islands and Caribbean Sea.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1880.                                 | 3 06   |    | Brit. Admiralty Chart; curves of equal magnetic variation, 1880.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1884, February 8.                     | 2 20   | E. | Lieut. R. B. Peck, U. S. S. Swatara; in $\phi = 17^{\circ} 58' N$ , $\lambda = 76^{\circ} 48' W$ . ; Naval Professional Papers, No. 19, Washington, 1886. [Double weight is assigned to this value.—SCH.]                                                                                                                                                                                                                                                                                                                                                                 |

GROUP II.—*Series of Magnetic Stations, etc.*—Continued.

## 24.—PANAMA, NEW GRANADA.

 $\phi = 8^{\circ} 57'.1$        $\lambda = 79^{\circ} 32'.2$  W. of Gr.

(Cathedral.)

|    |                    |      |    |                                                                                                                                                                                                                                                                |
|----|--------------------|------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | 1700. 0.           | 10   | E. | Approximate value; Edm. Halley's isogonic chart for 1700, reproduced in Greenwich observations of 1869. [Not used.—SCH.]                                                                                                                                       |
| 1  | 1775, November.    | 7 49 |    | Encycl. Brit., 7th edition, 1842.                                                                                                                                                                                                                              |
| 2  | 1790, October 3.   | 7 49 |    | Don A. Malaspina; Berliner Astronomisches Jahrbuch, Vol. 53, for 1828, p. 188.                                                                                                                                                                                 |
|    | 1791, December.    | 7 49 |    | Encycl. Brit., 7th edition, 1842. [Probably same authority as for preceding date; not used.—SCH.]                                                                                                                                                              |
| 3  | 1802..             | 8 00 |    | Encycl. Brit., 7th edition, 1842.                                                                                                                                                                                                                              |
| 4  | 1822..             | 7 00 |    | Hall; in $\phi = 8^{\circ} 58'$ , $\lambda = 79^{\circ} 21'$ W. Becquerel's <i>Traité du Magnétisme</i> , Paris, 1846. [The weight $\frac{1}{2}$ is assigned to this value.—SCH.]                                                                              |
| 5  | 1837..             | 7 02 |    | Sir Edw. Belcher; in $\phi = 8^{\circ} 57'$ , $\lambda = 79^{\circ} 29'$ W. Phil. Trans. Roy. Soc., 1843.                                                                                                                                                      |
| 6  | 1849..             | 7 15 |    | Hughes; Brit. Admiralty Chart.                                                                                                                                                                                                                                 |
|    | 1849..             | 6 55 |    | Major W. H. Emory, Mexican Boundary Commissioner; in $\phi = 8^{\circ} 57'$ , $\lambda = 79^{\circ} 29'$ W.; Coast Survey Report for 1856, p. 223. [Mean, $7^{\circ} 5'$ E.—SCH.]                                                                              |
| 7  | 1858..             | 6 17 |    | Karl Friesach; in $\phi = 8^{\circ} 57'$ , $\lambda = 79^{\circ} 31'$ W. Sir Edw. Sabine's Contributions to Terr. Mag., in Phil. Trans. Roy. Soc. for 1875.                                                                                                    |
| 8  | 1866, May 14.      | 5 56 |    | Prof. W. Harkness, U. S. N.; in $\phi = 8^{\circ} 55'$ , $\lambda = 79^{\circ} 30'.5$ . Smithsonian Contributions to Knowledge, No. 239, Washington, 1873.                                                                                                     |
| 9  | 1873, December 25. | 6 57 |    | From log-books of the Benicia and Richmond; Hydrographic Office, Navy Dept., Washington; in $\phi = 7^{\circ} 26'$ , $\lambda = 79^{\circ} 54'$ W., off Point Mala. [Reduced to Panama — $38'$ , hence decl'n $6^{\circ} 19'$ E.; weight $\frac{1}{2}$ .—SCH.] |
| 10 | 1880..             | 5 24 |    | Brit. Admiralty Chart; curves of equal magnetic variation, 1880.                                                                                                                                                                                               |
| 11 | 1883, February 22. | 5 02 |    | Annales du Bureau des Longitudes, tome 3, Paris, 1883, p. 396-7. Promenade near the Cathedral, in $\phi = 8^{\circ} 57'$ , $\lambda = 79^{\circ} 31'$ W.                                                                                                       |
| 12 | 1884, March 20.    | 5 23 | E. | Lieut. C. Belknap, U. S. S. Vandalia; in $\phi = 9^{\circ} 22'$ , $\lambda = 79^{\circ} 54'$ W. Naval Prof. Papers, No. 19, Washington, 1886. [Reduction to Panama inappreciable.—SCH.]                                                                        |

RESULTS FOR GROUP II.—Magnetic stations mainly in the central part of the United States between the Appalachian and Rocky Mountain ranges, with additions in British North America, Canada, the West Indies, and Central America.

Geographical positions and expressions for the secular variation of the magnetic declination  $D$  (+ west, — east). The letter  $m$  stands for  $t-1850.0$ , or for the difference in time, expressed in years and fraction of a year, for any time  $t$  and the middle of the century, within the range of observation at any station.

| No. | Name of station and State.                | Latitude.          | West Longitude.    | The magnetic declination, expressed as a function of time.                                           |
|-----|-------------------------------------------|--------------------|--------------------|------------------------------------------------------------------------------------------------------|
| 1   | York Factory, British North America.      | 56 59.9            | 92 26              | $D = + 4^{\circ}.43 + 14^{\circ}.11 \sin (1.4 m - 95^{\circ}.6)$                                     |
| 2   | Sault de Ste. Marie, Mich.                | 46 29.9            | 84 20.1            | $D = + 1.54 + 2.70 \sin (1.45 m - 58.5)$                                                             |
| 3 { | Duluth, Minn., and<br>Superior City, Wis. | 46 45.5<br>46 39.9 | 92 04.5<br>92 04.2 | $D = - 7.70 + 2.41 \sin (1.4 m - 120.0)^*$                                                           |
| 4   | Pierrepont Manor, N. Y.                   | 43 44.5            | 76 03.0            | $D = + 5.95 + 3.78 \sin (1.4 m - 22.2)$                                                              |
| 5   | Toronto, Canada.                          | 43 39.4            | 79 23.5            | $D = + 3.60 + 2.82 \sin (1.4 m - 44.7)$<br>$+ 0.09 \sin (9.3 m + 136)$<br>$+ 0.08 \sin (19 m + 247)$ |
| 6   | Grand Haven, Mich.                        | 43 05.2            | 86 12.6            | $D = - 4.95 + 0.0380 m + 0.00120 m^2$                                                                |
| 7   | Buffalo, N. Y.                            | 42 52.8            | 78 53.5            | $D = + 3.66 + 3.47 \sin (1.4 m - 27.8)$                                                              |
| 8   | Detroit, Mich.                            | 42 20.0            | 83 03.0            | $D = - 0.97 + 2.21 \sin (1.5 m - 15.3)$                                                              |
| 9   | Erie, Pa.                                 | 42 07.8            | 80 05.4            | $D = + 2.17 + 2.69 \sin (1.5 m - 27.3)$                                                              |
| 10  | Chicago, Ill.                             | 41 50.0            | 87 36.7            | $D = - 6.00 + 0.0274 m + 0.00074 m^2$                                                                |
| 11  | Cleveland, Ohio.                          | 41 30.3            | 81 42.0            | $D = + 0.10 + 2.07 \sin (1.4 m - 6.2)$                                                               |
| 12  | Omaha, Nebr.                              | 41 15.7            | 95 56.5            | $D = - 11.62 + 0.0406 m + 0.00020 m^2$                                                               |
| 13  | Pittsburgh, Pa.                           | 40 27.6            | 80 00.8            | $D = + 1.85 + 2.45 \sin (1.45 m - 28.4)$                                                             |
| 14  | Marietta, Ohio.                           | 39 25              | 81 28              | $D = + 0.02 + 2.89 \sin (1.4 m - 40.5)$                                                              |
| 15  | Cincinnati, Ohio.                         | 39 08.6            | 84 25.3            | $D = - 2.40 + 2.62 \sin (1.42 m - 39.8)$                                                             |
| 16  | Saint Louis, Mo.                          | 38 38.0            | 90 12.2            | $D = - 6.04 + 2.60 \sin (1.4 m - 48.0)^*$                                                            |
| 17  | Florence, Ala.                            | 34 47.2            | 87 41.5            | $D = - 4.25 + 2.33 \sin (1.3 m - 52.8)$                                                              |
| 18  | Mobile, Ala.                              | 30 41.4            | 88 02.5            | $D = - 4.38 + 2.69 \sin (1.45 m - 76.4)$                                                             |
| 19  | New Orleans, La.                          | 29 57.2            | 90 03.9            | $D = - 5.61 + 2.57 \sin (1.4 m - 61.9)$                                                              |
| 20  | San Antonio, Tex.                         | 29 25.4            | 98 29.3            | $D = - 7.40 + 2.88 \sin (1.35 m - 81.8)^*$                                                           |
| 21  | Key West, Fla.                            | 24 33.5            | 81 48.5            | $D = - 3.70 + 3.16 \sin (1.35 m - 35.1)$                                                             |
| 22  | Havana, Cuba.                             | 23 09.3            | 82 21.5            | $D = - 4.32 + 2.45 \sin (1.3 m - 20.8)^*$                                                            |
| 23  | Kingston, Port Royal, Jamaica.            | 17 55.9            | 76 50.6            | $D = - 4.48 + 2.28 \sin (1.1 m + 10.1)$                                                              |
| 24  | Panama, New Granada.                      | 8 57.1             | 79 32.2            | $D = - 5.67 + 2.16 \sin (1.1 m - 27.4)$                                                              |

\* Expression very uncertain.

## GROUP II.—Comparison of observed and computed Magnetic Declinations.

| Year and fraction.                     | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction. | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.            | Obs'd decl'n. | Comp'd decl'n. | O—C.  |
|----------------------------------------|---------------|----------------|-------|--------------------|---------------|----------------|-------|-------------------------------|---------------|----------------|-------|
| YORK FACTORY, BR. N. A.                |               |                |       | TORONTO, CANADA.   |               |                |       | GRAND HAVEN, MICH.—continued. |               |                |       |
| 1725.5                                 | +19.00        | +18.54         | + .46 | 1840.1             | + 1.45        | + 1.36         | + .09 | 1859.6                        | — 4.40        | — 4.47         | + .07 |
| 1787.5                                 | + 5.00        | + 5.19         | — .19 | 1841.5             | 1.24          | 1.40           | — .16 | 1865.6                        | 4.25          | 4.07           | — .18 |
| 1819.7                                 | — 6.00        | — 5.01         | — .99 | 1842.5             | 1.32          | 1.45           | — .13 | 1873.7                        | 3.47          | 3.38           | — .09 |
| 1843.6                                 | 9.01          | 9.22           | + .21 | 1845.5             | 1.48          | 1.52           | — .04 | 1880.5                        | — 2.43        | — 2.68         | + .25 |
| 1857.6                                 | 7.62          | 9.62           | +2.00 | 1846.5             | 1.51          | 1.54           | — .03 | BUFFALO, N. Y.                |               |                |       |
| 1879.5                                 | 7.00          | 7.02           | + .02 | 1847.5             | 1.55          | 1.56           | — .01 | 1797.5                        | 0.00          | + 0.26         | — .26 |
| 1884.7                                 | — 6.66        | — 5.88         | — .78 | 1848.5             | 1.59          | 1.57           | + .02 | 1798.5                        | + 0.50        | 0.24           | + .26 |
| SAULT DE STE. MARIE, MICH.             |               |                |       | 1849.5             | 1.62          | 1.59           | + .03 | 1837.5                        | 1.42          | 1.19           | + .23 |
| 1790.5                                 | 0.00          | + 0.01         | — .01 | 1850.5             | 1.64          | 1.62           | + .02 | 1839.5                        | 1.25          | 1.31           | — .06 |
| 1843.5                                 | — 1.13        | — 0.96         | — .17 | 1851.5             | 1.68          | 1.66           | + .02 | 1845.5                        | 1.42          | 1.71           | — .29 |
| 1844.8                                 | 1.02          | 0.93           | — .09 | 1853.5             | 1.77          | 1.76           | + .01 | 1859.5                        | 2.94          | 2.79           | + .15 |
| 1845.5                                 | 0.77          | 0.91           | + .14 | 1854.5             | 1.80          | 1.82           | — .02 | 1872.5                        | 3.87          | 3.89           | — .02 |
| 1846.8                                 | 0.67          | 0.87           | + .20 | 1855.5             | 1.87          | 1.88           | — .01 | 1873.5                        | 3.97          | 3.97           | .00   |
| 1856.7                                 | — 0.54        | — 0.49         | — .05 | 1856.5             | 1.94          | 1.95           | — .01 | 1885.7                        | + 5.07        | + 4.98         | + .09 |
| 1873.6                                 | + 0.08        | + 0.43         | — .35 | 1857.5             | 2.01          | 2.02           | — .01 | DETROIT, MICH.                |               |                |       |
| 1879.8                                 | 1.02          | 0.82           | + .20 | 1858.5             | 2.07          | 2.08           | — .01 | 1810.5                        | — 2.80        | — 3.10         | + .30 |
| 1880.6                                 | + 0.99        | + 0.88         | + .11 | 1859.5             | 2.12          | 2.14           | — .02 | 1822.5                        | 3.22          | 2.82           | — .40 |
| DULUTH, MINN., AND SUPERIOR CITY, WIS. |               |                |       | 1860.5             | 2.18          | 2.20           | — .02 | 1828.5                        | 2.83          | 2.60           | — .23 |
| 1859.5                                 | — 9.42        | —10.01         | + .59 | 1861.5             | 2.24          | 2.25           | — .01 | 1835.5                        | 2.17          | 2.30           | + .13 |
| 1861.5                                 | 10.20         | 10.04          | — .16 | 1862.5             | 2.26          | 2.29           | — .03 | 1840.5                        | 1.97          | 2.06           | + .09 |
| 1870.7                                 | 10.50         | 10.11          | — .39 | 1863.5             | 2.32          | 2.33           | — .01 | 1859.3                        | 0.70          | 1.01           | + .31 |
| 1871.5                                 | 10.67         | 10.11          | — .56 | 1864.5             | 2.36          | 2.37           | — .01 | 1865.5                        | 0.67          | 0.66           | — .01 |
| 1880.6                                 | — 9.76        | —10.05         | + .29 | 1865.5             | 2.41          | 2.41           | .00   | 1872.4                        | 0.42          | 0.28           | — .14 |
| PIERREPONT MANOR, N. Y.                |               |                |       | 1866.5             | 2.46          | 2.45           | + .01 | 1873.4                        | 0.29          | 0.22           | — .07 |
| 1823.7                                 | + 2.27        | + 2.71         | —0.44 | 1867.5             | 2.50          | 2.50           | .00   | 1876.4                        | — 0.08        | — 0.06         | — .02 |
| 1847.7                                 | 4.38          | 4.33           | +0.05 | 1868.5             | 2.55          | 2.55           | .00   | 1885.7                        | + 0.52        | + 0.40         | + .12 |
| 1856.9                                 | 5.17          | 5.13           | +0.04 | 1869.5             | 2.62          | 2.62           | .00   | ERIE, PA.                     |               |                |       |
| 1860.5                                 | 5.60          | 5.45           | +0.15 | 1870.5             | 2.70          | 2.69           | + .01 | 1786.8                        | + 0.53        | — 0.11         | + .64 |
| 1863.5                                 | 5.73          | 5.73           | .00   | 1871.5             | 2.80          | 2.78           | + .02 | 1793.5                        | — 0.70        | — 0.32         | — .38 |
| 1864.3                                 | 5.83          | 5.81           | + .02 | 1872.5             | 2.88          | 2.88           | .00   | 1795.5                        | — 0.72        | — 0.37         | — .35 |
| 1865.4                                 | 6.00          | 5.91           | + .09 | 1873.5             | 2.97          | 2.98           | — .01 | 1841.6                        | + 0.50        | + 0.45         | + .05 |
| 1866.7                                 | 6.25          | 6.03           | + .22 | 1874.5             | 3.07          | 3.09           | — .02 | 1855.5                        | 1.55          | 1.29           | + .26 |
| 1867.6                                 | 6.17          | 6.11           | + .06 | 1875.5             | 3.19          | 3.20           | — .01 | 1859.4                        | 1.65          | 1.56           | + .09 |
| 1868.4                                 | 6.17          | 6.19           | — .02 | 1876.5             | 3.31          | 3.30           | + .01 | 1862.6                        | 1.53          | 1.78           | — .25 |
| 1869.4                                 | 6.30          | 6.28           | + .02 | 1877.5             | 3.41          | 3.41           | .00   | 1867.3                        | 2.22          | 2.11           | + .11 |
| 1870.5                                 | 6.06          | 6.38           | — .32 | 1878.5             | 3.52          | 3.50           | + .02 | 1873.6                        | 2.31          | 2.55           | — .24 |
| 1874.8                                 | + 6.55        | + 6.77         | — .22 | 1879.5             | 3.62          | 3.58           | + .04 | 1876.5                        | + 2.83        | + 2.75         | + .08 |
|                                        |               |                |       | 1880.8             | 3.68          | 3.67           | + .01 |                               |               |                |       |
|                                        |               |                |       | 1884.6             | + 3.95        | + 3.87         | + .08 |                               |               |                |       |
|                                        |               |                |       | GRAND HAVEN, MICH. |               |                |       |                               |               |                |       |
|                                        |               |                |       | 1825.5             | — 5.25        | — 5.16         | — .09 |                               |               |                |       |
|                                        |               |                |       | 1837.5             | — 5.08        | — 5.24         | + .16 |                               |               |                |       |

## GROUP II.—Comparison of observed and computed Magnetic Declinations—Continued.

| Year and fraction.   | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction. | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.      | Obs'd decl'n. | Comp'd decl'n. | O—C.  |
|----------------------|---------------|----------------|-------|--------------------|---------------|----------------|-------|-------------------------|---------------|----------------|-------|
| ERIE, PA.—continued. |               |                |       | MARIETTA, OHIO.    |               |                |       | MOBILE, ALA.—continued. |               |                |       |
| 1877.9               | + 3.00        | + 2.84         | + .16 | 1810.5             | — 2.60        | — 2.86         | + .26 | 1843.5                  | — 6.93        | — 7.06         | + .13 |
| 1883.9               | 3.33          | 3.24           | + .09 | 1824.0             | 3.42          | 2.79           | — .63 | 1847.4                  | 7.07          | 7.03           | — .04 |
| 1885.7               | + 3.14        | + 3.36         | — .22 | 1838.5             | 1.54          | 2.39           | + .85 | 1857.1                  | 6.87          | 6.84           | — .03 |
| CHICAGO, ILL.        |               |                |       | 1845.3             | 2.42          | 2.10           | — .32 | 1875.4                  | 6.12          | 6.09           | — .03 |
| 1823.5               | — 6.20        | — 6.21         | + .01 | 1850.5             | 1.42          | 1.83           | + .41 | 1883.2                  | — 5.28        | — 5.66         | + .38 |
| 1857.6               | 5.77          | 5.75           | — .02 | 1864.1             | — 1.21        | — 1.01         | — .20 | NEW ORLEANS, LA.        |               |                |       |
| 1878.7               | — 4.55        | — 4.60         | + .05 | 1881.4             | + 0.20        | + 0.20         | .00   | 1720.5                  | — 2.00        | — 3.31         | +1.31 |
| CLEVELAND, OHIO.     |               |                |       | CINCINNATI, OHIO.  |               |                |       | 1768.5                  | 7.83          | 5.79           | —2.04 |
| 1796.7               | — 2.00        | — 1.95         | — .05 | 1806.5             | — 4.97        | — 4.97         | .00   | 1796.5                  | 5.10          | 7.37           | +2.27 |
| 1830.5               | 1.33          | 1.04           | — .29 | 1810.5             | 5.00          | 5.01           | + .01 | 1806.5                  | 8.05          | 7.77           | —0.28 |
| 1831.6               | 1.25          | 1.00           | — .25 | 1840.0             | 4.77          | 4.52           | — .25 | 1840.5                  | 8.33          | 8.10           | —0.23 |
| 1834.1               | 0.83          | 0.89           | + .06 | 1845.3             | 4.07          | 4.30           | + .23 | 1857.0                  | 8.00          | 7.69           | —0.31 |
| 1838.1               | 0.58          | 0.70           | + .12 | 1880.9             | — 2.24        | — 2.21         | — .03 | 1858.3                  | 7.86          | 7.59           | —0.27 |
| 1840.5               | 0.32          | 0.59           | + .27 | ST. LOUIS, MO.     |               |                |       | 1870.5                  | 7.10          | 7.02           | —0.08 |
| 1841.3               | 0.09          | 0.55           | + .46 | 1819.5             | —10.79        | — 8.64         | —2.15 | 1872.1                  | 6.66          | 6.93           | +0.27 |
| 1845.5               | — 0.65        | — 0.35         | — .30 | 1835.5             | 8.82          | 8.46           | —0.36 | 1880.2                  | — 6.46        | — 6.47         | +0.01 |
| 1859.5               | + 0.77        | + 0.36         | + .41 | 1838.5             | 7.75          | 8.38           | +0.63 | SAN ANTONIO, TEX.       |               |                |       |
| 1871.8               | 0.54          | 0.95           | — .41 | 1855.5             | 8.00          | 7.72           | —0.28 | 1825.5                  | —10.50        | —10.01         | — .49 |
| 1872.5               | 0.75          | 0.98           | — .23 | 1856.8             | 6.39          | 7.66           | +1.27 | 1836.5                  | 9.75          | 10.24          | + .49 |
| 1873.5               | 0.85          | 1.03           | — .18 | 1872.6             | 6.63          | 6.77           | +0.14 | 1874.5                  | 9.50          | 9.56           | + .06 |
| 1880.5               | + 1.64        | + 1.33         | + .31 | 1877.5             | 6.51          | 6.47           | —0.04 | 1878.4                  | — 9.37        | — 9.38         | + .01 |
| OMAHA, NEBR.         |               |                |       | 1878.6             | 6.56          | 6.40           | —0.16 | KEY WEST, FLA.          |               |                |       |
| 1819.7               | —12.78        | —12.67         | — .11 | 1879.7             | 6.22          | 6.33           | +0.11 | 1829.1                  | — 6.42        | — 6.52         | + .10 |
| 1869.1               | 10.71         | 10.77          | + .06 | 1886.8             | — 6.18        | — 5.88         | —0.30 | 1843.5                  | 6.03          | 5.89           | — .14 |
| 1872.8               | 10.74         | 10.59          | — .15 | FLORENCE, ALA.     |               |                |       | 1849.6                  | 5.48          | 5.54           | + .06 |
| 1877.8               | 10.37         | 10.34          | — .03 | 1818.5             | — 6.58        | — 6.58         | .00   | 1860.7                  | 4.78          | 4.82           | + .04 |
| 1878.7               | 10.66         | 10.29          | — .37 | 1835.5             | 6.47          | 6.46           | — .01 | 1861.2                  | 4.74          | 4.78           | + .04 |
| 1880.8               | —10.10        | —10.18         | + .08 | 1865.3             | 5.40          | 5.51           | + .11 | 1862.7                  | 4.67          | 4.68           | + .01 |
| PITTSBURG, PA.       |               |                |       | 1875.4             | 5.24          | 5.04           | — .20 | 1863.5                  | 4.61          | 4.62           | + .01 |
| 1840.6               | + 0.13        | + 0.21         | — .08 | 1881.7             | — 4.63        | — 4.72         | + .09 | 1864.5                  | 4.57          | 4.54           | — .03 |
| 1845.3               | 0.55          | 0.44           | + .11 | MOBILE, ALA.       |               |                |       | 1865.5                  | 4.53          | 4.47           | — .06 |
| 1878.7               | 2.36          | 2.41           | — .05 | 1814.5             | — 6.50        | — 6.50         | .00   | 1866.2                  | 4.50          | 4.42           | — .08 |
| 1884.7               | 2.68          | 2.76           | — .08 | 1835.5             | 7.20          | 7.05           | — .15 | 1879.2                  | 3.56          | 3.46           | — .10 |
| 1885.6               | + 2.93        | + 2.82         | + .11 | 1840.5             | — 7.08        | — 7.07         | — .01 | 1884.3                  | — 2.91        | — 3.09         | + .18 |

## GROUP II.—Comparison of observed and computed Magnetic Declinations—Continued.

| Year and fraction. | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.           | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.   | Obs'd decl'n. | Comp'd decl'n. | O—C.  |
|--------------------|---------------|----------------|-------|------------------------------|---------------|----------------|-------|----------------------|---------------|----------------|-------|
| HAVANA, CUBA.      |               |                |       | KINGSTON, JAMAICA—continued. |               |                |       | PANAMA, NEW GRANADA. |               |                |       |
| 1726.5             | — 4.57        | — 4.26         | — .31 | 1806.5                       | — 6.50        | — 5.88         | — .62 | 1775.8               | — 7.82        | — 7.71         | — .11 |
| 1732.3             | 4.50          | 4.58           | + .08 | 1820.0                       | 4.83          | 5.37           | + .54 | 1790.8               | 7.82          | 7.83           | + .01 |
| 1815.5             | 7.00          | 6.55           | — .45 | 1822.5                       | 4.90          | 5.26           | + .36 | 1802.5               | 8.00          | 7.79           | — .21 |
| 1816.6             | 5.50          | 6.52           | +1.02 | 1832.5                       | 5.22          | 4.84           | — .38 | 1822.5               | 7.00          | 7.49           | + .49 |
| 1833.0             | 5.83          | 5.99           | + .16 | 1833.5                       | 4.67          | 4.80           | + .13 | 1837.5               | 7.03          | 7.09           | + .06 |
| 1857.1             | 5.25          | 4.81           | — .44 | 1837.8                       | 4.30          | 4.61           | + .31 | 1849.5               | 7.08          | 6.69           | — .39 |
| 1858.5             | 5.75          | 4.74           | —1.01 | 1847.3                       | 3.67          | 4.20           | + .53 | 1858.5               | 6.28          | 6.34           | + .06 |
| 1879.2             | 3.90          | 3.59           | — .31 | 1857.2                       | 3.67          | 3.78           | + .11 | 1866.4               | 5.93          | 6.02           | + .09 |
| 1884.3             | — 2.73        | — 3.33         | + .60 | 1875.5                       | 4.00          | 3.07           | — .93 | 1873.9               | 6.32          | 5.71           | — .61 |
| KINGSTON, JAMAICA. |               |                |       | 1876.5                       | 3.58          | 3.04           | — .54 | 1880.5               | 5.40          | 5.44           | + .04 |
| 1732.2             | — 6.04        | — 6.46         | + .42 | 1880.5                       | 3.10          | 2.90           | — .20 | 1883.1               | 5.03          | 5.33           | + .30 |
| 1791.8             | — 6.78        | — 6.32         | — .46 | 1884.1                       | — 2.33        | — 2.80         | + .47 | 1884.2               | — 5.38        | — 5.29         | —0.09 |

## RESULTS FOR GROUP II—Continued.

Contents of columns: Year of first observation, and whole number of observations used in the discussion; probable error of an observation or of an expression; year of nearest easterly digression or magnetic elongation, with corresponding amount of maximum *east* declination; annual change for three modern epochs. East declination is indicated by a minus sign, as is also easterly increasing declination; westerly declination and westerly increase are indicated by a plus sign.

| Number. | Station.                             | Year of first observation. | Number of observations. | Probable error of an observation. | Nearest epoch of easterly elongation. | Extreme value of declination at epoch. | Annual change in— |           |           |
|---------|--------------------------------------|----------------------------|-------------------------|-----------------------------------|---------------------------------------|----------------------------------------|-------------------|-----------|-----------|
|         |                                      |                            |                         |                                   |                                       |                                        | 1885.0            | 1890.0    | 1895.0    |
| 1       | York Factory, Brit. N. A.            | 1725                       | 7                       | ±49                               | 1854                                  | — 9.7                                  | +14.0             | +16.0     | +17.5     |
| 2       | Sault de Ste. Marie, Mich.           | 1790                       | 9                       | 9                                 | 1828                                  | — 1.2                                  | + 4.0             | + 4.1     | + 4.1     |
| 3       | Duluth, Minn., & Superior City, Wis. | 1859                       | 5                       | 28                                | 1871 (?)                              | —10.1                                  | + 1.1 (?)         | + 1.5 (?) | + 1.9 (?) |
| 4       | Pierrepont Manor, N. Y.              | 1823                       | 13                      | 7                                 | 1802                                  | + 2.2                                  | + 5.0             | + 4.6     | + 4.2     |
| 5       | Toronto, Canada.                     | 1840                       | 39                      | 2                                 | ----                                  | ----                                   | + 2.3             | + 3.8     | + 4.4     |
| 6       | Grand Haven, Mich.                   | 1825                       | 6                       | 9                                 | 1834                                  | — 5.3                                  | + 7.3             | + 8.0     | ----      |
| 7       | Buffalo, N. Y.                       | 1797                       | 9                       | 10                                | 1806                                  | + 0.2                                  | + 4.8             | + 4.5     | + 4.2     |
| 8       | Detroit, Mich.                       | 1810                       | 11                      | 10                                | 1800                                  | — 3.2                                  | + 2.8             | + 2.5     | + 2.1     |
| 9       | Erie, Pa.                            | 1786                       | 13                      | 13                                | 1808                                  | — 0.5                                  | + 3.8             | + 3.5     | + 3.2     |
| 10      | Chicago, Ill.                        | 1823                       | 3                       | ----                              | 1832                                  | — 6.2                                  | + 4.7             | + 5.2     | + 5.6     |
| 11      | Cleveland, Ohio.                     | 1796                       | 13                      | 13                                | 1790                                  | — 2.0                                  | + 2.2             | + 2.0     | + 1.7     |
| 12      | Omaha, Nebr.                         | 1819                       | 6                       | 10                                | ----                                  | ----                                   | + 3.3             | + 3.4     | + 3.5     |
| 13      | Pittsburgh, Pa.                      | 1840                       | 5                       | 6                                 | 1808                                  | — 0.6                                  | + 3.4             | + 3.2     | + 3.0     |
| 14      | Marietta, Ohio.                      | 1810                       | 7                       | 23                                | 1815                                  | — 2.9                                  | + 4.2             | + 4.1     | + 3.9     |
| 15      | Cincinnati, Ohio.                    | 1806                       | 5                       | 10                                | 1815                                  | — 5.0                                  | + 3.8             | + 3.7     | + 3.6     |
| 16      | Saint Louis, Mo.                     | 1819                       | 10                      | 29                                | 1820 (?)                              | — 8.6                                  | + 3.8             | + 3.8     | + 3.7     |
| 17      | Florence, Ala.                       | 1818                       | 5                       | 7                                 | 1821                                  | — 6.6                                  | + 3.2             | + 3.2     | + 3.2     |
| 18      | Mobile, Ala.                         | 1814                       | 8                       | 8                                 | 1841                                  | — 7.1                                  | + 3.7             | + 3.9     | + 4.0     |
| 19      | New Orleans, La.                     | 1720                       | 10                      | 20                                | 1830                                  | — 8.2                                  | + 3.7             | + 3.8     | + 3.8     |
| 20      | San Antonio, Tex.                    | 1825                       | 4                       | 14                                | 1844                                  | —10.3                                  | + 3.3             | + 3.6     | + 3.8     |
| 21      | Key West, Fla.                       | 1829                       | 12                      | 3                                 | 1809                                  | — 6.9                                  | + 4.4             | + 4.2     | + 4.0     |
| 22      | Havana, Cuba.                        | 1726                       | 9                       | 31                                | 1797                                  | — 6.8                                  | + 3.0             | + 2.9     | + 2.7     |
| 23      | Kingston, Jamaica.                   | 1732                       | 14                      | 22                                | 1759 (?)                              | — 6.8                                  | + 1.7             | + 1.5     | + 1.3     |
| 24      | Panama, New Granada.                 | 1775                       | 12                      | ±11                               | 1793                                  | — 7.8                                  | + 2.4             | + 2.4     | + 2.3     |

## RESULTS FOR GROUP II—Completed.

Ephemeris of magnetic declinations. Computed magnetic declination at each station for every tenth year of the series, and after 1850 for every fifth year. A plus sign signifies westerly declination, a minus sign easterly declination. The first tabular result for any station indicates that the first observation made there falls between that tabular date and the next one following it.

| Year<br>(January 1). | York Factory,<br>Brit. North<br>Amer. | Sault de Ste. Ma-<br>rie, Mich. | Duluth, Minn.,<br>and Superior<br>City, Wis. | Pierrepont Ma-<br>nor, N. Y. | Toronto, Canada. | Grand<br>Haven,<br>Mich. | Buffalo, N. Y. | Detroit, Mich. | Erie, Pa. | Chicago, Ill. | Cleveland, Ohio. | Omaha, Nebr. |
|----------------------|---------------------------------------|---------------------------------|----------------------------------------------|------------------------------|------------------|--------------------------|----------------|----------------|-----------|---------------|------------------|--------------|
| 1700                 | °                                     | °                               | °                                            | °                            | °                | °                        | °              | °              | °         | °             | °                | °            |
| 10                   | ---                                   | ---                             | ---                                          | ---                          | ---              | ---                      | ---            | ---            | ---       | ---           | ---              | ---          |
| 20                   | +18.4                                 |                                 |                                              |                              |                  |                          |                |                |           |               |                  |              |
| 30                   | 18.5                                  |                                 |                                              |                              |                  |                          |                |                |           |               |                  |              |
| 40                   | +17.7                                 |                                 |                                              |                              |                  |                          |                |                |           |               |                  |              |
| 1750                 | +16.1                                 | ---                             | ---                                          | ---                          | ---              | ---                      | ---            | ---            | ---       | ---           | ---              | ---          |
| 60                   | 13.8                                  |                                 |                                              |                              |                  |                          |                |                |           |               |                  |              |
| 70                   | 11.0                                  |                                 |                                              |                              |                  |                          |                |                |           |               |                  |              |
| 80                   | 7.7                                   |                                 |                                              |                              |                  |                          |                |                | +0.2      |               |                  |              |
| 90                   | +4.3                                  | +0.0                            |                                              |                              |                  |                          | +0.44          |                | -0.2      |               | -2.0             |              |
| 1800                 | +0.9                                  | -0.5                            | ---                                          | ---                          | ---              | ---                      | +0.22          | -3.2           | -0.46     | ---           | -1.9             | ---          |
| 10                   | -2.3                                  | 0.9                             |                                              |                              |                  |                          | 0.21           | 3.11           | 0.52      |               | 1.7              |              |
| 20                   | 5.1                                   | 1.1                             |                                              | +2.6                         |                  | -5.0                     | 0.41           | 2.90           | 0.39      | -6.2          | 1.4              |              |
| 30                   | 7.7                                   | 1.16                            |                                              | 3.05                         | +0.8             | 5.2                      | 0.79           | 2.55           | -0.09     | 6.2           | 1.06             |              |
| 40                   | -8.9                                  | -1.04                           |                                              | +3.72                        | +1.32            | -5.2                     | +1.35          | -2.09          | +0.36     | -6.2          | -0.61            |              |
| 1850                 | -9.6                                  | -0.76                           | -9.8                                         | +4.52                        | +1.60            | -4.95                    | +2.05          | -1.56          | +0.94     | -6.0          | -0.12            | ---          |
| 55                   | 9.7                                   | 0.57                            | 9.9                                          | 4.96                         | 1.85             | 4.74                     | 2.43           | 1.26           | 1.26      | 5.8           | +0.13            |              |
| 60                   | 9.5                                   | 0.34                            | 10.02                                        | 5.41                         | 2.17             | 4.45                     | 2.84           | 0.99           | 1.60      | 5.6           | 0.38             | -11.2        |
| 65                   | 9.2                                   | -0.07                           | 10.08                                        | 5.87                         | 2.39             | 4.11                     | 3.25           | 0.69           | 1.94      | 5.4           | 0.63             | 10.97        |
| 70                   | -8.6                                  | +0.21                           | -10.11                                       | +6.33                        | +2.66            | -3.71                    | +3.67          | -0.41          | +2.30     | -5.16         | +0.87            | -10.73       |
| 1875                 | -7.9                                  | +0.52                           | -10.10                                       | +6.79                        | +3.14            | -3.25                    | +4.09          | -0.13          | +2.65     | -4.85         | +1.10            | -10.48       |
| 80                   | 6.9                                   | 0.84                            | 10.06                                        | 7.23                         | 3.62             | 2.73                     | 4.51           | +0.13          | 2.99      | 4.51          | 1.31             | 10.23        |
| 85                   | 5.8                                   | 1.18                            | 9.98                                         | 7.6                          | 3.88             | 2.15                     | 4.91           | 0.37           | 3.32      | 4.14          | 1.51             | 9.98         |
| 90                   | 4.6                                   | 1.52                            | 9.9                                          | 8.0                          | 4.12             | 1.5                      | 5.30           | 0.58           | 3.62      | 3.7           | 1.68             | 9.68         |
| 95                   | -3.2                                  | +1.9                            | -9.7                                         | +8.4                         | +4.5             | -0.8                     | +5.66          | +0.78          | +3.9      | -3.3          | +1.83            | -9.4         |

## RESULTS FOR GROUP II—Completed.

| Year<br>(January 1). | Pittsburgh, Pa. | Marietta, Ohio. | Cincinnati, Ohio. | Saint Louis, Mo. | Florence, Ala. | Mobile, Ala. | New Orleans,<br>La. | San Antonio,<br>Tex. | Key West, Fla. | Havana, Cuba. | Kingston, Port<br>Royal, Jamaica. | Panama, New<br>Granada. |
|----------------------|-----------------|-----------------|-------------------|------------------|----------------|--------------|---------------------|----------------------|----------------|---------------|-----------------------------------|-------------------------|
| 1700                 | 0               | 0               | 0                 | 0                | 0              | 0            | 0                   | 0                    | 0              | 0             | 0                                 | 0                       |
| 10                   | ---             | ---             | ---               | ---              | ---            | ---          | ---                 | ---                  | ---            | ---           | ---                               | ---                     |
| 20                   |                 |                 |                   |                  |                |              | -3.3                |                      |                | -3.9          |                                   |                         |
| 30                   |                 |                 |                   |                  |                |              | 3.6                 |                      |                | 4.5           | -6.4                              |                         |
| 40                   |                 |                 |                   |                  |                |              | -4.1                |                      |                | -5.0          | -6.6                              |                         |
| 1750                 | ---             | ---             | ---               | ---              | ---            | ---          | -4.7                | ---                  | ---            | -5.5          | -6.7                              | ---                     |
| 60                   |                 |                 |                   |                  |                |              | 5.3                 |                      |                | 6.0           | 6.8                               |                         |
| 70                   |                 |                 |                   |                  |                |              | 5.9                 |                      |                | 6.3           | 6.7                               | -7.6                    |
| 80                   |                 |                 |                   |                  |                |              | 6.5                 |                      |                | 6.6           | 6.6                               | 7.8                     |
| 90                   |                 |                 |                   |                  |                |              | -7.1                |                      |                | -6.7          | -6.4                              | -7.8                    |
| 1800                 | ---             | ---             | -4.85             | ---              | ---            | -5.81        | -7.52               | ---                  | ---            | -6.8          | -6.1                              | -7.8                    |
| 10                   |                 | -2.9            | 5.00              | -8.6             | -6.50          | 6.30         | 7.88                |                      |                | 6.7           | 5.8                               | 7.7                     |
| 20                   |                 | 2.8             | 5.00              | 8.6              | 6.58           | 6.71         | 8.11                | -9.8                 | -6.76          | 6.5           | 5.4                               | 7.5                     |
| 30                   |                 | 2.7             | 4.83              | 8.6              | 6.54           | 6.97         | 8.18                | 10.1                 | 6.49           | 6.1           | 5.0                               | 7.3                     |
| 40                   | +0.18           | -2.33           | -4.52             | -8.3             | -6.37          | -7.07        | -8.10               | -10.3                | -6.07          | -5.7          | -4.5                              | -7.0                    |
| 1850                 | +0.68           | -1.86           | -4.08             | -8.0             | -6.11          | -6.99        | -7.88               | -10.2                | -5.52          | -5.2          | -4.1                              | -6.7                    |
| 55                   | 0.96            | 1.57            | 3.82              | 7.8              | 5.93           | 6.90         | 7.71                | 10.2                 | 5.20           | 4.9           | 3.9                               | 6.4                     |
| 60                   | 1.26            | 1.27            | 3.53              | 7.5              | 5.74           | 6.75         | 7.52                | 10.1                 | 4.86           | 4.7           | 3.7                               | 6.3                     |
| 65                   | 1.56            | 0.94            | 3.23              | 7.2              | 5.53           | 6.57         | 7.29                | 9.93                 | 4.51           | 4.4           | 3.5                               | 6.1                     |
| 70                   | +1.87           | -0.60           | -2.92             | -6.9             | -5.30          | -6.36        | -7.05               | -9.75                | -4.15          | -4.10         | -3.3                              | -5.9                    |
| 1875                 | +2.18           | -0.26           | -2.60             | -6.6             | -5.06          | -6.12        | -6.77               | -9.54                | -3.77          | -3.82         | -3.1                              | -5.7                    |
| 80                   | 2.49            | +0.10           | 2.27              | 6.3              | 4.81           | 5.84         | 6.49                | 9.30                 | 3.40           | 3.56          | 2.9                               | 5.5                     |
| 85                   | 2.78            | 0.45            | 1.95              | 6.0              | 4.55           | 5.54         | 6.18                | 9.03                 | 3.04           | 3.3           | 2.8                               | 5.3                     |
| 90                   | 3.06            | 0.79            | 1.63              | 5.7              | 4.28           | 5.23         | 5.87                | 8.7                  | 2.68           | 3.0           | 2.6                               | 5.1                     |
| 95                   | +3.3            | +1.1            | -1.3              | -5.4             | -4.0           | -4.9         | -5.6                | -8.4                 | -2.33          | -2.8          | -2.5                              | -4.9                    |

**GROUP III.**—*Collection of Magnetic Declinations from the earliest to the present time, observed on or near the Pacific coast of the United States and west of the Rocky Mountains and extending over the region from the Isthmus of Tehuantepec, Mexico, northward to Bering Strait and the Arctic Ocean, coast of Alaska.*

To these are added observations at a station in Kamtchatka and at two stations in the Sandwich Islands. This collection, however, comprises only places for which sufficient data were found for the discussion of the secular change of the declination.

Since the issue of the last edition of this paper a valuable collection of magnetic data has been published by Assistant G. Davidson, in Appendix No. 7, Report for 1885, entitled "Collection of some Magnetic Variations off the Coasts of California and Mexico, observed by Spanish Navigators in the last Quarter of the Eighteenth Century." The contents of this communication bearing directly upon our researches, it was submitted by me to a careful scrutiny, when its value became at once apparent, as it enabled me to assign for that early period a closely approximate value for the declination for any part of the coast between San Blas, a leading Mexican port at the time, and Vancouver Island. By means of these observations, when properly discussed, as satisfactory a value could be given as if it had been directly observed, and consequently I have introduced such results in the general collection of declinations at all places where observations were wanting about that period and in some instances made use of such values as checks on observations which appeared doubtful. It will therefore be proper to explain the method of procedure and give the results deduced before presenting the general collection of data at the secular-change stations on the Pacific coast.

All observations in question were made at sea, hence individually they give little information for any particular place, but collectively their value becomes apparent if it can be shown that the probable error of a single observation is reasonably small and the law of geographical distribution of the declination can be made out satisfactorily. This was effected by plotting all observed values for localities not more than about  $4^{\circ}$  of arc or about 240 nautical miles distant from the coast and representing the distribution of the declination as a function of the latitude and longitude disregarding the effect of the secular change during the interval 1774 to 1790; in other words, making no allowance for reduction to mean epoch.

To treat so large a number of observations by application of the method of least squares, the 122 observations selected as within our limit were united into mean values, for 7 groups, which could readily be marked out on the chart. No rejection was made and the values forming each group may be identified, if desired, by the epoch and their latitude and longitude without special reference to Appendix No. 7. These groups are as follows: In the table the groups are marked "A" to "G," and the headings No.,  $\tau$ ,  $\varphi$ ,  $\lambda$ , D indicate the running number, the year and fraction, the latitude, the west longitude, and observed declination, respectively.

| No.      | $\tau$ | $\varphi$ | $\lambda$ | D     | No.                | $\tau$ | $\varphi$ | $\lambda$ | D     | No.      | $\tau$ | $\varphi$ | $\lambda$ | D     |
|----------|--------|-----------|-----------|-------|--------------------|--------|-----------|-----------|-------|----------|--------|-----------|-----------|-------|
| GROUP A. |        |           |           |       | GROUP A—Continued. |        |           |           |       | GROUP B. |        |           |           |       |
| 1        | 1775.2 | 21.4      | 110.3     | — 4.5 | 10                 | 1779.9 | 21.6      | 110.8     | — 5.0 | 1        | 1774.1 | 20.8      | 113.8     | — 5.0 |
| 2        | 90.1   | 21.2      | 106.2     | — 6.0 | 11                 | 79.9   | 21.6      | 110.3     | — 5.0 | 2        | 74.1   | 20.5      | 113.4     | — 5.0 |
| 3        | 90.9   | 22.7      | 111.4     | — 7.5 | 12                 | 88.2   | 21.5      | 104.9     | — 5.0 | 3        | 75.2   | 20.6      | 113.9     | — 4.5 |
| 4        | 90.9   | 22.8      | 108.0     | — 7.0 | 13                 | 88.9   | 23.8      | 109.4     | — 6.5 | 4        | 75.2   | 20.2      | 112.9     | — 4.5 |
| 5        | 90.9   | 22.7      | 107.0     | — 6.0 | 14                 | 88.8   | 22.9      | 108.7     | — 5.0 | 5        | 75.2   | 19.8      | 110.7     | — 5.0 |
| 6        | 90.9   | 22.5      | 106.2     | — 5.0 | 15                 | 88.8   | 22.7      | 108.6     | — 4.5 | 6        | 75.2   | 18.6      | 110.5     | — 5.0 |
| 7        | 79.9   | 23.0      | 111.0     | — 6.5 | 16                 | 88.8   | 22.2      | 107.2     | — 4.5 | 7        | 75.2   | 18.6      | 110.7     | — 5.2 |
| 8        | 79.9   | 22.8      | 110.1     | — 6.0 | 17                 | 1788.8 | 21.9      | 105.8     | — 4.5 | 8        | 79.2   | 20.6      | 112.4     | — 5.0 |
| 9        | 79.9   | 21.8      | 111.4     | — 5.0 |                    |        |           |           |       | 9        | 79.2   | 20.4      | 110.0     | — 5.5 |

## GROUP III.—Collection of Magnetic Declinations from the earliest to the present time—Continued.

| No.                | $\tau$ | $\phi$ | $\lambda$ | D     | No.                | $\tau$ | $\phi$ | $\lambda$ | D     | No.                | $\tau$ | $\phi$ | $\lambda$ | D     |
|--------------------|--------|--------|-----------|-------|--------------------|--------|--------|-----------|-------|--------------------|--------|--------|-----------|-------|
| GROUP B—Continued. |        |        |           |       | GROUP D—Continued. |        |        |           |       | GROUP F—Continued. |        |        |           |       |
| 10                 | 1779.2 | 20.0   | 111.6     | — 6.0 | 3                  | 1779.9 | 23.8   | 117.4     | — 9.5 | 5                  | 1775.5 | 41.0   | 124.2     | —14.0 |
| 11                 | 79.2   | 20.1   | 116.8     | — 7.0 | 4                  | 88.9   | 33.4   | 117.9     | —11.0 | 6                  | 75.6   | 42.4   | 125.0     | —17.0 |
| 12                 | 79.1   | 20.5   | 111.8     | — 5.0 | 5                  | 88.9   | 29.8   | 116.2     | —10.0 | 7                  | 75.7   | 44.3   | 125.9     | —18.0 |
| 13                 | 79.2   | 20.4   | 114.5     | — 6.0 | 6                  | 88.7   | 32.6   | 120.8     | — 9.0 | 8                  | 75.7   | 42.6   | 124.6     | —17.0 |
| 14                 | 88.2   | 20.2   | 112.7     | — 5.5 | 7                  | 88.7   | 31.7   | 118.7     | — 8.5 | 9                  | 75.7   | 39.7   | 124.2     | —16.0 |
| 15                 | 88.2   | 20.3   | 113.8     | — 5.5 | 8                  | 88.8   | 30.6   | 116.4     | — 8.0 | 10                 | 79.7   | 43.8   | 128.8     | —16.0 |
| 16                 | 88.2   | 20.4   | 116.6     | — 6.0 | 9                  | 88.8   | 28.3   | 119.0     | — 6.9 | 11                 | 79.7   | 42.0   | 126.8     | —15.5 |
| 17                 | 90.1   | 20.5   | 114.2     | — 6.9 | 10                 | 90.8   | 32.8   | 121.8     | —11.0 | 12                 | 79.7   | 40.9   | 125.4     | —15.0 |
| 18                 | 1790.1 | 20.2   | 115.9     | — 6.8 | 11                 | 90.8   | 31.0   | 120.4     | — 9.0 | 13                 | 79.7   | 39.6   | 124.4     | —14.0 |
| GROUP C.           |        |        |           |       | 12                 | 1790.8 | 29.4   | 119.3     | — 8.5 | 14                 | 79.7   | 39.5   | 124.6     | —13.5 |
| 1                  | 1779.9 | 22.3   | 112.7     | — 5.5 | GROUP E.           |        |        |           |       | 15                 | 79.7   | 38.9   | 124.0     | —13.0 |
| 2                  | 88.9   | 24.6   | 111.6     | — 7.0 | 1                  | 1774.8 | 36.8   | 123.0     | —11.0 | 16                 | 88.7   | 40.0   | 125.5     | —16.0 |
| 3                  | 88.8   | 23.6   | 112.8     | — 5.0 | 2                  | 74.8   | 36.2   | 122.0     | —11.0 | 17                 | 90.6   | 43.2   | 127.9     | —15.0 |
| 4                  | 79.9   | 27.1   | 116.5     | — 8.5 | 3                  | 75.7   | 37.9   | 123.3     | —16.0 | 18                 | 90.7   | 41.3   | 126.0     | —14.5 |
| 5                  | 79.9   | 26.1   | 115.6     | — 7.5 | 4                  | 75.8   | 37.7   | 123.8     | —15.0 | 19                 | 1790.7 | 39.4   | 125.4     | —13.8 |
| 6                  | 79.9   | 25.3   | 114.6     | — 7.0 | 5                  | 75.8   | 36.7   | 123.2     | —14.0 | GROUP G.           |        |        |           |       |
| 7                  | 79.9   | 24.4   | 118.5     | — 7.0 | 6                  | 79.8   | 37.6   | 123.2     | —13.0 | 1                  | 1774.6 | 48.3   | 125.2     | —18.3 |
| 8                  | 79.9   | 23.4   | 117.3     | — 7.0 | 7                  | 79.8   | 37.2   | 123.1     | —12.5 | 2                  | 75.5   | 47.6   | 128.4     | —17.0 |
| 9                  | 79.9   | 23.0   | 116.0     | — 6.5 | 8                  | 79.8   | 36.0   | 122.6     | —12.0 | 3                  | 75.5   | 47.5   | 126.5     | —17.0 |
| 10                 | 79.9   | 22.8   | 115.1     | — 6.0 | 9                  | 79.8   | 34.8   | 122.2     | —11.0 | 4                  | 75.5   | 47.4   | 126.6     | —17.5 |
| 11                 | 79.9   | 22.5   | 114.3     | — 5.5 | 10                 | 79.7   | 37.8   | 122.8     | —13.0 | 5                  | 75.5   | 46.5   | 128.4     | —16.0 |
| 12                 | 88.9   | 25.7   | 112.6     | — 9.0 | 11                 | 88.7   | 36.2   | 125.4     | —10.5 | 6                  | 75.6   | 47.1   | 128.5     | —18.0 |
| 13                 | 88.8   | 27.1   | 117.0     | — 6.0 | 12                 | 88.7   | 35.2   | 124.2     | —10.0 | 7                  | 75.6   | 49.2   | 128.0     | —19.0 |
| 14                 | 88.8   | 25.7   | 115.2     | — 5.0 | 13                 | 90.6   | 37.6   | 123.4     | —14.5 | 8                  | 75.6   | 49.7   | 128.0     | —18.0 |
| 15                 | 88.8   | 25.0   | 114.6     | — 5.5 | 14                 | 90.8   | 35.3   | 123.0     | —12.0 | 9                  | 75.6   | 46.2   | 124.3     | —17.0 |
| 16                 | 88.8   | 24.7   | 113.9     | — 5.3 | 15                 | 90.7   | 37.5   | 123.7     | —13.3 | 10                 | 75.7   | 47.8   | 129.0     | —19.0 |
| 17                 | 88.8   | 24.2   | 113.5     | — 5.2 | 16                 | 1790.7 | 37.1   | 122.5     | —13.0 | 11                 | 90.2   | 49.9   | 127.6     | —17.8 |
| 18                 | 90.8   | 24.8   | 115.5     | — 8.0 | GROUP F.           |        |        |           |       | 12                 | 90.3   | 49.0   | 128.0     | —17.1 |
| 19                 | 90.8   | 23.8   | 114.1     | — 9.0 | 1                  | 1774.6 | 42.6   | 124.3     | —15.5 | 13                 | 90.3   | 48.7   | 128.4     | —18.0 |
| 20                 | 1790.8 | 23.1   | 112.4     | — 8.5 | 2                  | 74.6   | 39.8   | 124.3     | —11.2 | 14                 | 90.3   | 49.0   | 128.8     | —18.5 |
| GROUP D.           |        |        |           |       | 3                  | 75.4   | 41.8   | 125.2     | —14.0 | 15                 | 90.6   | 48.2   | 125.2     | —18.0 |
| 1                  | 1779.8 | 30.9   | 119.8     | —10.5 | 4                  | 75.4   | 41.5   | 124.8     | —14.5 | 16                 | 90.6   | 48.3   | 125.2     | —17.0 |
| 2                  | 79.8   | 29.8   | 118.9     | —10.0 |                    |        |        |           |       | 17                 | 90.6   | 48.4   | 126.4     | —15.0 |
|                    |        |        |           |       |                    |        |        |           |       | 18                 | 90.6   | 48.9   | 126.9     | —15.5 |
|                    |        |        |           |       |                    |        |        |           |       | 19                 | 90.6   | 49.5   | 127.2     | —16.0 |
|                    |        |        |           |       |                    |        |        |           |       | 20                 | 1790.6 | 49.6   | 127.7     | —17.0 |

## GROUP III.—Collection of Magnetic Declinations from the earliest to the present time—Continued.

## RESULTS FOR EACH GROUP.

| Group. | $\tau$ | $\varphi$ | $\lambda$ | D     |
|--------|--------|-----------|-----------|-------|
|        |        | °         | °         | °     |
| A      | 1785.9 | 22.3      | 108.7     | — 5.5 |
| B      | 1780.2 | 20.2      | 113.1     | — 5.5 |
| C      | 1785.1 | 24.5      | 114.7     | — 6.7 |
| D      | 1787.1 | 30.3      | 118.9     | — 9.3 |
| E      | 1782.2 | 36.7      | 123.2     | —12.6 |
| F      | 1779.8 | 41.3      | 125.3     | —14.9 |
| G      | 1783.0 | 48.3      | 127.2     | —17.3 |
| Mean   | 1783.3 | 31.9      | 118.7     | —10.3 |

For the relation  $D = f(\varphi, \lambda)$  I have found it sufficient to make use of the following terms only, others not having any sensible effect upon the result, nor would they be warranted by the uncertainties in the observations themselves:

$$D = D_0 + x \Delta\varphi + y \Delta\lambda \cos \varphi + z \Delta\varphi^2$$

where

$$\Delta\varphi = \varphi - \varphi_0 = \varphi - 31^\circ.9$$

$$\Delta\lambda = \lambda - \lambda_0 = \lambda - 118^\circ.7$$

$D_0$  = normal declination for epoch 1783.3 =  $-10^\circ.3$

$D$  = declination for any place (within the geographical limits of the investigation) whose latitude is  $\varphi$  and whose longitude is  $\lambda$ . The conditional equations are as follows:

$$+4.8 = -9.6x - 9.3y + 92z$$

$$+4.8 = -11.7x - 5.3y + 137z$$

$$+3.6 = -7.4x - 3.6y + 55z$$

$$+1.0 = -1.6x + 0.2y + 3z$$

$$-2.3 = +4.8x + 3.6y + 23z$$

$$-4.6 = +9.4x + 5.0y + 88z$$

$$-7.0 = +16.4x + 5.6y + 269z$$

and the normal equations become:

$$\begin{aligned} 666.7x + 333.7y + 2456.4z + 299.6 &= 0 \\ 196.9y + 250.1z + 153.3 &= 0 \\ 110957.0z + 1036.9 &= 0 \end{aligned}$$

hence

$$x = -0.381$$

$$y = -0.132$$

$$z = -0.0006 \text{ and } D = -10^\circ.3 - 0.381 \Delta\varphi - 0.132 \Delta\lambda \cos \varphi - 0.0006 \Delta\varphi^2$$

with the following residuals:

| Group. | Obs'd D. | Comp'd D. | O — C |
|--------|----------|-----------|-------|
|        | °        | °         | °     |
| A      | — 5.5    | — 5.5     | 0.0   |
| B      | — 5.5    | — 5.2     | —0.3  |
| C      | — 6.7    | — 7.0     | +0.3  |
| D      | — 9.3    | — 9.7     | +0.3  |
| E      | —12.6    | —12.6     | 0.0   |
| F      | —14.9    | —14.6     | —0.3  |
| G      | —17.3    | —17.4     | +0.1  |

GROUP III.—*Collection of Magnetic Declinations from the earliest to the present time*—Continued.

which is a sufficiently close representation. For the probable error of the mean of a group we have

$$r=0.674 \sqrt{\frac{[vv]}{n-m}}=\pm 0^{\circ}.205 \text{ or } \pm 12'.$$

On an average the number of observations in a group is 17, hence the probable error  $r_0$  of any individual observation for declination is  $0.205 \sqrt{17}$  or  $\pm 0^{\circ}.845$  or  $\pm 51'$ , a tolerably fair value, considering the time when these observations were made. It also compares favorably with the estimated average probable error of an observation made by Vancouver.

To draw the isogonics as represented on the accompanying chart (No. 30) it was only necessary to find the roots of the above equation for certain assumed values for  $D$ , ranging from  $-5^{\circ}$  to  $-18^{\circ}$ , and plot the corresponding values of  $\phi$  and  $\lambda$  for each line.

A comparison of the isogonics of 1783 with those of the present time shows that a century ago the general direction of the curves was not very unlike the present one, but they were less crowded than now. In the space between San Blas and the northern part of Vancouver Island we find a change of declination in 1783 of  $13^{\circ}$ , whereas in the same space we now have  $15^{\circ}$  of change, and, roughly speaking, the declination a century ago was  $4^{\circ}$  less easterly than at present in the region of San Blas and  $6^{\circ}$  less than at present at Vancouver Island.

*Series of Magnetic Stations mainly on the Pacific Coast and in the region west of the Rocky Mountains.*

The stations of this western series are irregularly scattered over the region extending from the Isthmus of Tehuantepec, Mexico, to the Arctic Ocean, Alaska. Added thereto is a station in Kamchatka, Eastern Siberia, and two on the Sandwich Islands group.

In this series the observations for magnetic declination have been collected and discussed for secular variation at the following places:

- |                                       |                                                     |
|---------------------------------------|-----------------------------------------------------|
| 1. Acapulco, Mexico.                  | 16. Olympia, Wash. Ter'y.                           |
| 2. Vera Cruz, Mexico.                 | 17. Seattle, Duwamish Bay, Wash. Ter'y.             |
| 3. City of Mexico, Mexico.            | 18. Port Townsend, Wash. Ter'y.                     |
| 4. San Blas, Mexico.                  | 19. Nee-ah Bay, Cape Flattery, Wash. Ter'y.         |
| 5. El Paso, Texas.                    | 20. Nootka, Vancouver Island.                       |
| 6. Magdalena Bay, Lower Cal.          | 21. Sitka, Alaska.                                  |
| 7. San Diego, Cal.                    | 22. Port Mulgrave, Yakutat Bay, Alaska.             |
| 8. Santa Barbara, Cal.                | 23. Port Etches, Alaska.                            |
| 9. Monterey, Cal.                     | 24. St. Paul, Kodiak Island.                        |
| 10. San Francisco, Cal.               | 25. Captain's and Iliuliuk harbors, Unalashka Is'd. |
| 11. Salt Lake City, Utah.             | 26. Port Clarence, Alaska.                          |
| 12. Cape Mendocino, Cal.              | 27. Chamisso Island, Kotzebue Sound.                |
| 13. Vancouver, Wash. Ter'y.           | 28. Petropavlovsk, Kamchatka.                       |
| 14. Wallula, Wash. Ter'y.             | 29. Kailua, Is'd of Hawaii, Sandwich Is'ds.         |
| 15. Cape Disappointment, Wash. Ter'y. | 30. Honolulu, Is'd of Oahu, Sandwich Is'ds.         |

The first column of the record for any station contains the running number of the values used in the discussion, the second the date of observation, the third the observed value, and the fourth the name of the observer, the geographical position of the station, the reference to publication, and other pertinent remarks.

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## 1.—ACAPULCO, MEXICO.

 $\phi = 16^{\circ} 50'.5$        $\lambda = 99^{\circ} 53'.5$  W. of Gr.

(South of Fort San Diego.)

|   |                        | o /    |    |                                                                                                                                                                                                          |
|---|------------------------|--------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1744..                 | 3      | E. | Anson; Hansteen's <i>Magnetismus der Erde</i> , 1819.                                                                                                                                                    |
| 2 | 1791, April 29.        | 7 44   |    | Don A. Malaspina, observed on land. <i>Berliner Jahrbuch</i> , vol. 53, for 1828.                                                                                                                        |
| 3 | 1822..                 | 8 40   |    | Hall; in $\phi = 16^{\circ} 50'$ , $\lambda = 99^{\circ} 51'$ W. <i>Becquerel's Traité du Magnétisme</i> , Paris, 1846.                                                                                  |
| 4 | 1828..                 | 9 07   |    | Capt. Beechey; <i>Becquerel</i> , as above.                                                                                                                                                              |
|   | 1837..                 | 8 23   |    | Sir Edw. Belcher; Fort San Diego, in $\phi = 16^{\circ} 50'.9$ , $\lambda = 99^{\circ} 52'.2$ W. Admiralty chart of Acapulco.                                                                            |
| 5 | 1838..                 | 8 13   |    | Sir Edw. Belcher; <i>Phil. Trans. Roy. Soc.</i> , 1843.                                                                                                                                                  |
|   | 1838..                 | 8 17   |    | Du Petit Thouars; <i>Voyage of the Frigate Venus</i> .                                                                                                                                                   |
|   | 1841..                 | 8 17   |    | Duflot de Mofras' <i>Explorations of Oregon</i> , Paris, 1844. [Probably Du Petit Thouars' value; not used.—SCH.]                                                                                        |
| 6 | 1866, May 30.          | 8 22   |    | W. Harkness, Prof. U. S. N., in $\phi = 16^{\circ} 50'.1$ , $\lambda = 99^{\circ} 52'.3$ W. <i>Observations on Terrestrial Magnetism</i> , Smithsonian Contributions to Knowledge, No. 239, 1873, p. 61. |
| 7 | 1874, March 17.        | 8 38.7 |    | G. Dewey, Comdr. U. S. Str. <i>Narragansett</i> , Lieuts. Z. L. Tanner and E. J. Young, observers; in $\phi = 16^{\circ} 50'.5$ , $\lambda = 99^{\circ} 55'.4$ W.                                        |
| 8 | 1880, November 23, 24. | 7 56.6 |    | H. E. Nichols, Lieut. U. S. N., assist. U. S. Coast and Geodetic Survey; Coconut Grove, close to Prof. Harkness' station of 1866; in $\phi = 16^{\circ} 49'.2$ , $\lambda = 99^{\circ} 56'.3$ W.         |
| 9 | 1882, November 18.     | 7 54   | E. | U. S. S. <i>Ranger</i> , Lieut. W. P. Ray, in $\phi = 16^{\circ} 51'$ , $\lambda = 99^{\circ} 56'$ W. <i>Naval Professional Papers</i> No. 19, Washington, 1886.                                         |

## 2.—VERA CRUZ, MEXICO.

 $\phi = 19^{\circ} 12'.0$        $\lambda = 96^{\circ} 08'.8$  W. of Gr.

(Castle San Juan d'Ulloa.)

|   |                            | o /    |    |                                                                                                                                                                                                                                                     |
|---|----------------------------|--------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1726 to 1727.              | 2 15   | E. | Joseph Harris; <i>Phil. Trans. Roy. Soc.</i> (abridged), 1824-'34.                                                                                                                                                                                  |
| 2 | 1769..                     | 6 40   |    | } <i>Encycl. Brit.</i> , seventh edition, 1842.                                                                                                                                                                                                     |
|   | 1769, March 15.            | 6 28   |    |                                                                                                                                                                                                                                                     |
| 3 | 1776..                     | 7 30   |    | Don Ulloa; <i>Encycl. Brit.</i> , seventh edition, 1842.                                                                                                                                                                                            |
| 4 | 1815..                     | 10 37  |    | Malony; <i>Encycl. Brit.</i> , seventh edition, 1842. [Weight $\frac{1}{4}$ assigned to this value.—SCH.]                                                                                                                                           |
| 5 | 1819, April 27.            | 9 16   |    | Wise; <i>Encycl. Brit.</i> , seventh edition, 1842.                                                                                                                                                                                                 |
| 6 | 1839..                     | 8 22   |    | Behard; $\phi = 19^{\circ} 12'$ , $\lambda = 96^{\circ} 09'$ W. <i>Phil. Trans. Roy. Soc.</i> , Sir Edw. Sabine's <i>Contributions to Terr. Magn.</i> , No. xiv, vol. 165, 1875.                                                                    |
| 7 | 1856, August 7, 8.         | 8 17   |    | August Sonntag; in $\phi = 19^{\circ} 12'$ , $\lambda = 96^{\circ} 09'$ W., at the villa la Guaca, 200 yds. south of the city; <i>Smithsonian Contributions to Knowledge</i> , Washington, 1860; also, <i>Coast Survey Report</i> for 1856, p. 214. |
| 8 | 1861..                     | 8 20   |    | English Admiralty Chart, No. 523, corrected to 1861.                                                                                                                                                                                                |
| 9 | 1880, February 10, 11, 12. | 7 26.3 | E. | Lieut. S. M. Ackley, U. S. N., asst. U. S. Coast and Geodetic Survey; north-east bastion of Castle San Juan d'Ulloa, $\phi = 19^{\circ} 12'.2$ , $\lambda = 96^{\circ} 08'.5$ W.                                                                    |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## 3.—CITY OF MEXICO, MEXICO.

 $\phi = 19^{\circ} 26'.0$        $\lambda = 99^{\circ} 11'.6$  W. of Gr.

(Observatorio Nacional.)

|    |                                               |        |    |                                                                                                                                                                                                                                                                       |
|----|-----------------------------------------------|--------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1769, June.                                   | 5 20   | E. | Don Alzate; Hansteen's <i>Magnetismus der Erde</i> , 1819.                                                                                                                                                                                                            |
|    | 1769, December.                               | 5 35   |    | Don Alzate; reference as above.                                                                                                                                                                                                                                       |
| 2  | 1775--                                        | 6 42   |    | Velasquez de Leon; <i>Memoria del Observatorio Meteorologico Central de Mexico</i> ; Por V. Reyes, Mexico, 1880.                                                                                                                                                      |
| 3  | 1803, December                                | 8 08   |    | Alex. von Humboldt; Hansteen's <i>Magnetismus der Erde</i> , 1819.                                                                                                                                                                                                    |
| 4  | 1849--                                        | 8 30.2 |    | Gomez de la Cortina; <i>Memoria del Observatorio Meteorologico Central de Mexico</i> ; Por V. Reyes, Mexico, 1880.                                                                                                                                                    |
| 5  | 1850--                                        | 8 35.2 |    | Velasquez y Teran; F. Diaz Covarrubias' <i>Tratado de Topografia y Geodesia</i> , Mexico, 1869, tomo 1, p. 221.                                                                                                                                                       |
| 6  | 1856, December 10-17.                         | 8 46   |    | August Sonntag; <i>Observations on Terr. Mag. in Mexico</i> , Smithsonian Cont's to Knowl., Washington, 1860; also Coast Survey Report for 1856, p. 214.                                                                                                              |
| 7  | 1858--                                        | 8 22.3 |    | Alamazan; in <i>Mem. del Observatorio Central</i> ; F. Diaz Covarrubias' <i>Tratado de Top. y Geod.</i> , Mexico, 1869.                                                                                                                                               |
| 8  | 1860--                                        | 8 30   |    | Salazar Llarregui; in <i>Mem. del Observatorio Central</i> ; F. Diaz Covarrubias' <i>Tratado</i> , as above.                                                                                                                                                          |
|    | 1862--                                        | 8 20.5 |    | Diaz Covarrubias; <i>Tratado</i> , as above.                                                                                                                                                                                                                          |
| 9  | 1862--                                        | 8 34.8 |    | Iglesias; <i>Memoria del Observatorio Meteorologico Central de Mexico</i> ; Por V. Reyes, Mexico, 1880.                                                                                                                                                               |
|    | 1866--                                        | 8 08.5 |    | Ponce de Leon; <i>Tratado de Topografia y Geodesia</i> , Mexico, 1869, tomo 1, p. 221.                                                                                                                                                                                |
| 10 | 1867--                                        | 8 09.3 |    |                                                                                                                                                                                                                                                                       |
| 11 | 1868--                                        | 8 10.0 |    | Fernandez y Diaz Covarrubias; <i>Tratado</i> , as before.                                                                                                                                                                                                             |
| 12 | 1879, September, October, November, December. | 8 34.5 |    | <i>Memoria sobre el Departamento Magnetico del Observatorio Meteorologico Central de Mexico</i> , Por V. Reyes, Mexico, 1880. [The weight one-half is given to this value.—SCH.]                                                                                      |
| 13 | 1884, April 5, 8, 9, 11, 15, 19.              | 8 19.0 | E. | Observatorio Central (at Tacubaya), M. Barcena, director; official, newspaper slip communicated by the Mexican Consul at San Francisco. The observations of April 15 were made by Prof. G. Davidson, assist. Coast and Geodetic Survey; he found $8^{\circ} 13'.9$ E. |

## 4.—SAN BLAS, MEXICO.

 $\phi = 21^{\circ} 32'.5$        $\lambda = 105^{\circ} 18'.4$  W. of Gr.

(Custom House.)

|   |                 |       |    |                                                                                                                                                                                                         |
|---|-----------------|-------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1788, March 9.  | 5     | E. | Don Esteban Martinez; in the <i>Princessa</i> ; $\phi = 21^{\circ} 30'$ , $\lambda = 105\frac{1}{2}^{\circ}$ W. Asst. Davidson's collection, Coast and Geodetic Survey Report for 1885, Appendix No. 7. |
| 2 | 1791, April 12. | 7 28  |    | Don A. Malaspina; observed on shore. <i>Berliner Astron. Jahrbuch</i> , vol. 53, for 1828; also <i>Encycl. Brit.</i> , seventh edition, 1842.                                                           |
| 3 | 1821-'22.       | 8 40  |    | Hall; <i>Encycl. Brit.</i> , seventh edition, 1842.                                                                                                                                                     |
|   | 1828--          | 11 06 | E. | Capt. F. W. Beechey; <i>Beechey's Narrative of a Voyage to the Pacific</i> , 1825-'28; also Becquerel's <i>Traité du Magnétisme</i> , Paris, 1846. [Not used.—SCH.]                                     |

## GROUP III.—Series of Magnetic Stations mainly on the Pacific Coast, etc.—Continued.

## SAN BLAS, MEXICO—Continued.

|   |                            |        |    |                                                                                                                                                                                                                        |
|---|----------------------------|--------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | 1837--                     | 8 34   | E. | Sir Edw. Belcher; in $\phi = 21^{\circ} 32'$ , $\lambda = 105^{\circ} 16'$ W. Phil. Trans. Roy. Soc., 1843.                                                                                                            |
|   | 1837--                     | 9 09   |    | Du Petit Thouars; Voyage de la Vénus, 1841. Gen. Sir Edw. Sabine's Cont's to Terr. Mag., No. xiv. Phil. Trans. Roy. Soc., vol. 165, part 1, 1875; position in $\phi = 21^{\circ} 32'$ , $\lambda = 105^{\circ} 16'$ W. |
| 5 | 1838--                     | 8 47   |    | Sir Edw. Belcher; in the Sulphur; reference as abo                                                                                                                                                                     |
| 6 | 1839--                     | 9 00   |    | Sir Edw. Belcher; Phil. Trans. Roy. Soc., 1843.                                                                                                                                                                        |
| 7 | 1841--                     | 9 12   |    | Duflot de Mofras' Exploration of Oregon, Paris, 1844.                                                                                                                                                                  |
| 8 | 1874, February 23, 24, 26. | 9 08.2 |    | G. Dewey, Comdr. U. S. S. Narragansett, Lieuts. Z. L. Tanner and E. J. Young, observers, in $\phi = 21^{\circ} 32'.4$ , $\lambda = 105^{\circ} 18'.7$ W.                                                               |
| 9 | 1880, December 5.          | 9 18.1 | E. | H. E. Nichols, Lieut. U. S. N., asst. U. S. Coast and Geodetic Survey; near Custom House, station of Sir E. Belcher of 1839; in $\phi = 21^{\circ} 32'.2$ , $\lambda = 105^{\circ} 18'.1$ W.                           |

## 5.—EL PASO, TEX.

 $\phi = 31^{\circ} 46'$        $\lambda = 106^{\circ} 30'$  W. of Gr.

|   |                   |         |    |                                                                                                                                                                                                               |
|---|-------------------|---------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1852--            | 12 24   | E. | Major W. H. Emory, Commissioner United States and Mexican boundary survey; Amer. Acad. of Sci., vol. vi, new series, 1856. At Frontera in $\phi = 31^{\circ} 49'$ , $\lambda = 106^{\circ} 29'$ W.            |
| 2 | 1859, January 20. | 12 25.0 |    | J. H. Clark, U. S. Commissioner; Report of Commissioner of General Land Office, 47th Cong., Sen. Exec. Doc. No. 70, Washington, 1882; at Frontera in $\phi = 31^{\circ} 49'$ , $\lambda = 106^{\circ} 33'$ W. |
| 3 | 1878--            | 12 25.2 |    | At astronomical monument, Fort Bliss; in $\phi = 31^{\circ} 45'.5$ , $\lambda = 105^{\circ} 29'.1$ W. Report of Chief of Engineers, U. S. A. for 1879, vol. iii.                                              |
| 4 | 1884, April 8.    | 12 05   | E. | Prof. G. Davidson, asst. Coast and Geodetic Survey; about 200 yds. north of R. R. depot, in $\phi = 31^{\circ} 46'$ , $\lambda = 106^{\circ} 30'$ W. MS. at C. and G. Survey Office.                          |

## 6.—MAGDALENA BAY, LOWER CALIFORNIA.

 $\phi = 24^{\circ} 38'.4$        $\lambda = 112^{\circ} 08'.9$  W. of Gr.

(Near village on Man-of-War Cove.)

|   |               |         |    |                                                                                                                                                                                               |
|---|---------------|---------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1783. 3.      | 6 47    | E. | Deduced from 122 observations by Spanish navigators along the coast between San Blas and Nootka; see preceding investigation.                                                                 |
| 2 | 1837--        | 8 15    |    | Du Petit Thouars; voyage of the Frigate Venus.                                                                                                                                                |
|   | 1837--        | 8 17    |    | Voyage of the Frigate Venus. } Gen. Sir Edw. Sabine, in Phil. Trans.                                                                                                                          |
| 3 | 1839--        | 9 15    |    | Sir Edw. Belcher in $\phi = 24^{\circ} 38'$ , } Roy. Soc., vol. 165, part 1, 1875; Cont's to Terr. Mag., xiv.                                                                                 |
|   | 1841--        | 8 15    |    | Duflot de Mofras; Explorations of Oregon, Paris, 1844; in $\phi = 24^{\circ} 36'$ , $\lambda = 112^{\circ} 05'$ W. [Not used.—SCH.]                                                           |
| 4 | 1866, June 9. | 10 40.5 | E. | W. Harkness, Prof. U. S. N.; Cruise of the Monadnock, 1865-'6, Smithsonian Contributions to Knowledge, No. 239, Washington, 1873; in $\phi = 24^{\circ} 40'$ , $\lambda = 112^{\circ} 07'$ W. |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## MAGDALENA BAY, LOWER CALIFORNIA—Continued.

|   |                       |                 |                                                                                                                                                                                                                        |
|---|-----------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | 1871, March and June. | ° /<br>11 00 E. | G. Bradford, asst. Coast Survey, near village on Man-of-War Cove, in $\phi = 24^{\circ} 37'.5$ , $\lambda = 112^{\circ} 13'.3$ W. Chart in Coast Survey archives.                                                      |
| 6 | 1873, March 5, 6, 7.  | 10. 36. 6       | W. Eimbeck, assist. Coast Survey, near village on Man-of-War Cove, in $\phi = 24^{\circ} 38'.4$ , $\lambda = 112^{\circ} 08'.9$ W., near Belcher's and Bradford's stations. Record in Coast Survey archives.           |
| 6 | 1873, June 23.        | 10 30. 8        | G. Dewey, Comdr. U. S. S. Narragansett; Lieuts. Z. L. Tanner and E. J. Young, observers. [Double weight given to this value.—SCH.]                                                                                     |
| 7 | 1881, February 24.    | 10 29.1 E.      | H. E. Nichols, Lieut. Comdr. U. S. N., assist U. S. Coast and Geodetic Survey; at Eimbeck's station of 1873, in $\phi = 24^{\circ} 38'.4$ , $\lambda = 112^{\circ} 08'.9$ W. [Double weight given to this value.—SCH.] |

## 7.—SAN DIEGO, CAL.

 $\phi = 32^{\circ} 42'.1$        $\lambda = 117^{\circ} 14.3'$  W. of Gr.

(La Playa, Point Loma.)

|   |                            |                 |                                                                                                                                                                                                                                                     |
|---|----------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1783. 3.                   | ° /<br>10 26 E. | Deduced from 122 observations by Spanish navigators along the coast between San Blas and Nootka; see preceding investigation.                                                                                                                       |
| 2 | 1792--                     | 11 0            | Capt. G. Vancouver; Vancouver's Voyage of Discovery, etc., 1790-'95, vol. 2, p. 475, London, 1798; also Hansteen's <i>Magnetismus der Erde</i> , 1819. In $\phi = 32^{\circ} 39'$ , $\lambda = 117^{\circ} 17'$ W.                                  |
|   | 1793--                     | 11 0            | Reference as above; in $\phi = 32^{\circ} 42'$ , $\lambda = 116^{\circ} 53'$ W. Observed on board ship on or near the coast. [Not used.—SCH.]                                                                                                       |
| 3 | 1839--                     | 12 20. 6        | Sir Edw. Belcher; in $\phi = 32^{\circ} 41'$ , $\lambda = 117^{\circ} 13'$ W. Phil. Trans. Roy. Soc., 1841.                                                                                                                                         |
|   | 1841--                     | 11 0            | Duflot de Mofras, <i>Explorations of Oregon</i> , Paris, 1844; in $\phi = 32^{\circ} 39'.5$ , $\lambda = 117' 17'$ W. [Not used.—SCH.]                                                                                                              |
| 4 | 1851, April 28 to May 7.   | 12 28. 8        | G. Davidson, asst. Coast Survey; near La Playa, in $\phi = 32^{\circ} 42'.2$ , $\lambda = 117^{\circ} 14'.6$ W., Coast Survey Report for 1856, p. 229.                                                                                              |
| 5 | 1853, October 15.          | 12 31. 7        | Lieut. W. P. Trowbridge, asst. Coast Survey; at La Playa, near the custom house. Coast Survey Report for 1856.                                                                                                                                      |
| 6 | 1866, June 15.             | 13 09. 4        | W. Harkness, Prof. U. S. N.; in $\phi = 32^{\circ} 42'$ , $\lambda = 117^{\circ} 13'$ W., at La Playa; Smithsonian Contributions to Knowledge, No. 239, Washington, 1873.                                                                           |
|   | 1871, May 28, 29, 30.      | 14 46. 7        | G. Davidson, Assist. Coast Survey, at New San Diego; in $\phi = 32^{\circ} 43'.1$ , $\lambda = 117^{\circ} 09'.7$ W., Coast and Geodetic Survey Report for 1881, App. 9. [Not used, distance from La Playa too great and reduction uncertain.—SCH.] |
| 7 | 1872, November 19, 20, 21. | 13 19. 4        | G. Davidson, assist. Coast Survey, and S. R. Throckmorton, aid; near La Playa, in $\phi = 32^{\circ} 42'.2$ , $\lambda = 117^{\circ} 14'.6$ W.; station of 1851. Coast and Geodetic Survey Report for 1881, App. 9.                                 |
|   | 1879--                     | 12 55           | Capt. W. A. Jones, from a plan of New San Diego, showing U. S. Barracks. [Not used.—SCH.]                                                                                                                                                           |
| 8 | 1881, April 6.             | 13 27. 6 E.     | H. E. Nichols, Lieut. Comdr. U. S. N., asst. Coast and Geodetic Survey, at Davidson's station of 1851, in $\phi = 32^{\circ} 42'.2$ , $\lambda = 117^{\circ} 14'.5$ W. Coast and Geodetic Survey Report for 1881, Appendix 9.                       |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## 8.—SANTA BARBARA, CAL.

 $\phi = 34^{\circ} 24'.2$        $\lambda = 119^{\circ} 43'.0$  W. of Gr.

(Astronomical station of 1869.)

|   |                       | $\phi$  | $\lambda$ |                                                                                                                                                                                                               |  |
|---|-----------------------|---------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 1 | 1783.3.               | 11 22   | E.        | Deduced from 122 observations by Spanish navigators along the coast between San Blas and Nootka; see preceding investigation.                                                                                 |  |
|   | 1793, November.       | 10 15   |           | Capt. G. Vancouver; Hansteen's <i>Magnetismus der Erde</i> , 1819. In $\phi = 34^{\circ} 24'$ , $\lambda = 119^{\circ} 16'$ W. [Not used—SCH.]                                                                |  |
| 2 | 1839..                | 13 28   |           | Sir Edw. Belcher; <i>Phil. Trans. Roy. Soc.</i> , 1841. In $\phi = 34^{\circ} 24'$ , $\lambda = 119^{\circ} 41'$ W.                                                                                           |  |
| 3 | 1869, November 16–19. | 15 11.9 |           | S. R. Throckmorton (G. Davidson, assist., chief of party), Coast and Geodetic Survey Report for 1881, Appendix 9. In $\phi = 34^{\circ} 24'.2$ , $\lambda = 119^{\circ} 42'.8$ W.; at outermost spur of hill. |  |
| 4 | 1881, April 14.       | 14 51.9 | E.        | H. E. Nichols, Lieut. Comdr. U. S. N., assist. Coast and Geodetic Survey; Report for 1881, App. 9. Near long wharf and the Burton House, in $\phi = 34^{\circ} 24'.6$ , $\lambda = 119^{\circ} 41'.5$ W.      |  |

## 9.—MONTEREY, CAL.

 $\phi = 36^{\circ} 36'.1$        $\lambda = 121^{\circ} 53'.6$  W. of Gr.

(Custom House.)

|   |                         | $\phi$ | $\lambda$ |                                                                                                                                                                                                                                                                                              |  |
|---|-------------------------|--------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 1 | 1783. 3.                | 12 26  | E.        | Deduced from 122 observations by Spanish navigators along the coast from San Blas to Nootka; see preceding investigation.                                                                                                                                                                    |  |
| 2 | 1786, September 14, 15. | 11 48  |           | La Perouse (J. F. G. de); at sea, a few miles from the anchorage, variation $-11^{\circ} 57'$ ; and twenty miles north and west from Pt. Pinos $-11^{\circ} 39'$ . <i>Voyage autour du monde</i> , Paris, 1797, vol. 3, pp. 302 and 390. Communicated by Mr. Marcus Baker, C. and G. Survey. |  |
| 3 | 1791, September 23.     | 10 56  |           | Don A. Malaspina; <i>Berliner Astron. Jahrbuch</i> , vol. 53, for 1828. Observations made on shore.                                                                                                                                                                                          |  |
| 4 | 1792, December.         | 12 22  |           | Capt. G. Vancouver; in $\phi = 36^{\circ} 36'$ , $\lambda = 121^{\circ} 34'$ W.; Vancouver's <i>Voyage of Discovery</i> , etc., 1790–'95, vol. ii, p. 51; London, 1798; also Hansteen's <i>Magnetismus der Erde</i> , 1819.                                                                  |  |
| 5 | 1794, November 13.      | 12 22  |           | Capt. G. Vancouver; in $\phi = 36^{\circ} 36'$ , $\lambda = 121^{\circ} 51'$ W.; Vancouver's <i>Voyage of Discovery</i> , etc., 1790–'95, vol. iii, p. 337; also Hansteen's <i>Magnetismus der Erde</i> , 1819. Probably taken on shore.                                                     |  |
|   | 1818, September.        | 16 30  |           | Capt. Golovnin (V. M.); apparently at Presidio, in $\phi = 36^{\circ} 36'.2$ . <i>Voyage around the World</i> , St. Petersburg, 1822, vol. 2. Communicated by Mr. Marcus Baker, Coast Survey. [Not used, apparently about $3^{\circ}$ in error—SCH.]                                         |  |
|   | 1827..                  | 15 38  |           | Capt. F. W. Beechey; <i>Phil. Trans. Roy. Soc.</i> , vol. 165, 1875, Sir Edw. Sabine's Cont's to <i>Terr. Mag.</i> , No. xiv. [Not used—SCH.]                                                                                                                                                |  |
| 6 | 1837..                  | 14 30  |           | Du Petit Thouars; <i>Voyage of the Frigate Venus</i> . Near Monterey.                                                                                                                                                                                                                        |  |
| 7 | 1839..                  | 14 30  |           | Sir Edw. Belcher; in $\phi = 36^{\circ} 36'$ , $\lambda = 121^{\circ} 53'$ W. <i>Phil. Trans. Roy. Soc.</i> , 1841.                                                                                                                                                                          |  |
| 8 | 1841..                  | 15 00  |           | Dufot de Mofras; <i>Exploration of Oregon</i> , Paris, 1844, at Presidio, in $\phi = 36^{\circ} 36'$ , $\lambda = 121^{\circ} 53'$ W.                                                                                                                                                        |  |
| 9 | 1843..                  | 14 00  | E.        | Chart of the harbor of Monterey, surveyed by Comdr. T. A. Dornin; position of fort $\phi = 36^{\circ} 36'.4$ , $\lambda = 121^{\circ} 52'.4$ W.                                                                                                                                              |  |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## MONTEREY, CAL.—Continued.

|    |                                   |            |                                                                                                                                                                                                                                          |
|----|-----------------------------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 | 1851, February 8.                 | 14 58.3 E. | G. Davidson, asst. Coast Survey; at Point Pinos, astronomical station, in $\phi=36^{\circ} 37'.8$ , $\lambda=121^{\circ} 55'.5$ W. Coast Survey Report for 1856, p. 229.                                                                 |
| 11 | 1854, May 29, 30.                 | 14 58.9    | W. P. Trowbridge, Lieut. U. S. A., assist. Coast Survey. Station near barracks of redoubt, in $\phi=36^{\circ} 36'.2$ , $\lambda=121^{\circ} 53'.8$ W. Coast and Geodetic Survey Report for 1881, Appendix 9.                            |
| 12 | 1873, August 30, 31, September 1. | 15 55.3    | G. Davidson, asst. Coast Survey, and S. R. Throckmorton, aid; near astronomical station; in $\phi=36^{\circ} 37'.8$ , $\lambda=121^{\circ} 55'.6$ W. Coast and Geodetic Survey Report for 1881, App. 9.                                  |
| 13 | 1881, April 20.                   | 15 53.9 E. | H. E. Nichols, Lt. Comdr. U. S. N., assist. Coast and Geodetic Survey; near Lieut. Trowbridge's station of 1854; in redoubt, $\phi=36^{\circ} 36'.2$ , $\lambda=121^{\circ} 53'.8$ W. Coast and Geodetic Survey Report for 1881, App. 9. |

## 10.—SAN FRANCISCO, CAL.

 $\phi=37^{\circ} 47'.5$        $\lambda=122^{\circ} 27'.3$  W. of Gr.

(Presidio.)

|    |                             |            |                                                                                                                                                                                                                                                                                                  |
|----|-----------------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | 1783. 3.                    | 12 55 E.   | Deduced from 122 observations by Spanish navigators along the coast from San Blas to Nootka; see preceding investigation.                                                                                                                                                                        |
| 2  | 1792, November 20.          | 12 48      | Capt. G. Vancouver; in $\phi=37^{\circ} 48'$ , $\lambda=122^{\circ} 07'.5$ W. Vancouver's voyage, 1798, vol. 2, p. 27. Taken on board ship, values varying from $-12^{\circ} 02'$ to $-13^{\circ} 32'$ . Communicated by Mr. Marcus Baker, Coast and Geodetic Survey. [Longitude defective—SCH.] |
|    | 1816, October.              | 16 05      | Kotzebue; Kotzebue's Voyage of Discovery, 1815-18; in $\phi=37^{\circ} 48'.6$ , $\lambda=122^{\circ} 12'.5$ W. [Not used—SCH.]                                                                                                                                                                   |
| 3  | 1818, September 20 (O. S.). | 15 00      | Capt. Golovnin (V. M.); voyage around the world, St. Petersburg, 1822, vol. 2. Communicated by Mr. M. Baker.                                                                                                                                                                                     |
|    | 1824--                      | 16 00      | Kotzebue. } [Not used—SCH.]                                                                                                                                                                                                                                                                      |
| 4  | 1827--                      | 15 27      | Beechey; } Becquerel's <i>Traité du Magnétisme</i> , Paris, 1846.                                                                                                                                                                                                                                |
| 5  | 1829, December 6.           | 14 55      | Erman (A. G.); <i>Reise um die Erde</i> , Berlin, 1835, vol. 1.                                                                                                                                                                                                                                  |
| 6  | 1830--                      | 14 51      | Erman (A. G.); <i>Phil. Trans. Roy. Soc.</i> , vol. 165, 1875. Sir Edw. Sabine's Cont's to <i>Terr. Mag.</i> , No. xiv.                                                                                                                                                                          |
| 7  | 1837--                      | 15 20      | Sir Edw. Belcher; in $\phi=37^{\circ} 48'$ , $\lambda=122^{\circ} 23'$ W. <i>Phil. Trans. Roy. Soc.</i> , 1841.                                                                                                                                                                                  |
|    | 1837--                      | 15 00      | Du Petit Thouars; voyage of the Frigate Venus.                                                                                                                                                                                                                                                   |
| 8  | 1839--                      | 15 20      | Sir Edw. Belcher; in $\phi=37^{\circ} 48'$ , $\lambda=122^{\circ} 23'$ W. <i>Phil. Trans. Roy. Soc.</i> , 1841.                                                                                                                                                                                  |
| 9  | 1841, October,              | 15 30      | Duflot de Mofras; exploration of Oregon, Paris, 1844; in $\phi=37^{\circ} 48'.5$ , $\lambda=122^{\circ} 28'.4$ W.                                                                                                                                                                                |
|    | 1842, January.              | 15 30      | Duflot de Mofras; as above. At Fort Point, Golden Gate.                                                                                                                                                                                                                                          |
| 10 | 1849-'50.                   | 15 40.8    | Ringgold, Comdr., U. S. N.; at Alcatraz Island, harbor of San Francisco.                                                                                                                                                                                                                         |
|    | 1852, February 18-28.       | 15 27.6    | G. Davidson, asst. Coast Survey; at Presidio, astronomical station; in $\phi=37^{\circ} 47'.5$ , $\lambda=122^{\circ} 27'.3$ W. Mean of daily maximum and minimum.                                                                                                                               |
|    | 1852, March 24.             | 15 28.8    | Coast Survey Report for 1856, p. 229. Mean value $=-15^{\circ} 28'.8$ .                                                                                                                                                                                                                          |
| 11 | 1852, April 21.             | 15 27.8    | See also C. and G. Survey Report for 1881, App. 9.                                                                                                                                                                                                                                               |
|    | 1852, May 28.               | 15 31.1    |                                                                                                                                                                                                                                                                                                  |
| 12 | 1858, June 3-8.             | 15 49.4    | Karl Friesach; <i>Reports Imp. Acad. of Sciences</i> , Vienna, 1850, vol. 38; at Dupont street, near Catholic ch.; in $\phi=37^{\circ} 47'.8$ , $\lambda=122^{\circ} 24'.0$ W.; second set of obser's corner Stockton and California sts. [Mean value $=-15^{\circ} 52'.8$ —SCH.]                |
|    | 1858, June 10-12.           | 15 56.2 E. |                                                                                                                                                                                                                                                                                                  |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## SAN FRANCISCO, CAL.—Continued.

|    |                                          |            |                                                                                                                                                                                              |
|----|------------------------------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13 | 1866, June 26.                           | 16 25.5 E. | W. Harkness, Prof. U. S. N.; east side of Yerba Buena Island; in $\phi = 37^{\circ} 49'$ , $\lambda = 122^{\circ} 21'$ W. Smithsonian Contributions to Knowledge, No. 239, Washington, 1873. |
| 14 | 1871, December 14, 15, 16.               | 16 23.1    | G. Davidson, asst. Coast Survey, and S. R. Throckmorton, aid; at Presidio station of 1852. Coast and Geodetic Survey Report for 1881, App. 9.                                                |
| 15 | 1872, October 26, 27, 28.                | 16 25.7    | Reference as above.                                                                                                                                                                          |
| 16 | 1873, June 25, 26, 27.                   | 16 25.4    |                                                                                                                                                                                              |
|    | 1873, August 19-23.                      | 16 24.0    |                                                                                                                                                                                              |
|    | 1873, November 12-16.                    | 16 25.4    |                                                                                                                                                                                              |
| 17 | 1874, January 10, 12, 13, 14.            | 16 26.9    | Reference as above.                                                                                                                                                                          |
|    | 1874, February 19, 20, 21.               |            |                                                                                                                                                                                              |
| 18 | 1879, March 12-15.                       | 16 34.0    | G. Davidson and B. A. Colonna, assts. Coast Survey; at Presidio. Reference as above.                                                                                                         |
| 19 | 1880, September 25, 26.                  | 16 28.3    | H. E. Nichols, Lieut. U. S. N., asst. Coast and Geodetic Survey; at the Presidio station. Reference as above.                                                                                |
|    | 1880, November 20.                       | 16 39.5    | W. H. Dall and M. Baker, Coast and Geodetic Survey; at the Presidio station. Reference as above. [Mean value for 1880-'81 = $-16^{\circ} 33'.9$ —SCH.]                                       |
| 20 | 1881, March 30, 31, April 1.             | 16 33.3    | W. Eimbeck, asst. Coast and Geodetic Survey; at Presidio. Reference as above.                                                                                                                |
|    | 1881, April 26, 27.                      | 16 31.9    | H. E. Nichols, Lt. Comdr. U. S. N., asst. Coast and Geodetic Survey; at Presidio station. Reference as above.                                                                                |
|    | 1881, July 12, November 1.               | 16 32.2    |                                                                                                                                                                                              |
|    | 1881, June 22, 23, 24, December 1, 2, 3. | 16 18.2    | J. S. Lawson, asst. Coast and Geodetic Survey; at Presidio station. Reference as above. [Mean of four values = $-16^{\circ} 28'.9$ for 1881.48—SCH.]                                         |
| 21 | 1883, June 3.                            | 16 38.6    | R. A. Marr, aid Coast and Geodetic Survey; at Presidio. MS. in archives.                                                                                                                     |
| 22 | 1884, September 5-16.                    | 16 32.3    | G. Davidson, asst. Coast and Geodetic Survey, and R. A. Marr, aid; at Presidio. MS. in archives.                                                                                             |
| 23 | 1885, August 4-12.                       | 16 33.4    | G. Davidson, asst. Coast and Geodetic Survey, and F. Morse, aid; at Presidio. MS. in archives.                                                                                               |
| 24 | 1886, April 21-24.                       | 16 33.1 E. | Observers, locality, and reference as above.                                                                                                                                                 |

## II.—SALT LAKE CITY, UTAH.

 $\phi = 40^{\circ} 46'.1$        $\lambda = 111^{\circ} 53'.8$  W. of Gr.

(Temple Square, astronomical station.)

|   |                 |            |                                                                                                                                                                                       |
|---|-----------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1850..          | 15 34 E.   | Major W. H. Emory, U. S. A.; Amer. Acad. of Science, vol. vi, new series, 1856. In $\phi = 40^{\circ} 46'$ , $\lambda = 112^{\circ} 08'$ W.                                           |
| 2 | 1866, August.   | 16 30      | Jesse W. Fox; letter from Surveyor-General's Office, dated Aug. 29, 1866. In $\phi = 40^{\circ} 46'$ , $\lambda = 111^{\circ} 54'$ W.                                                 |
| 3 | 1869, May 6-15. | 16 36.4 E. | G. W. Dean, asst. Coast Survey; Temple square, near astro'l station; in $\phi = 40^{\circ} 46'.0$ , $\lambda = 111^{\circ} 53'.8$ W. Coast and Geodetic Survey Rep. for 1881, App. 9. |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## SALT LAKE CITY, UTAH—Continued.

|   |                            |            |                                                                                                                                                                                                                    |
|---|----------------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | 1872--                     | 17 01 E.   | Report of Chief of Engineers, 1879, Part III, p. 2099, at Camp Douglass, near astronomical monument; in $\phi=40^{\circ} 45'.8$ , $\lambda=111^{\circ} 50'.2$ W.                                                   |
| 5 | 1878, August 15.           | 16 48.1    | Dr. T. E. Thorpe; Proc. Roy. Soc., No. 200, 1880. East of the President's house; in $\phi=40^{\circ} 46'.1$ , $\lambda=111^{\circ} 53'.7$ W.                                                                       |
|   | 1878, October 26, 28, 29.  | 16 44.2    | J. B. Baylor, aid Coast and Geodetic Survey; near Fourth street south and Second street east of Temple. Coast and Geodetic Survey Report for 1881, App. 9. [Mean of two determinations, $-16^{\circ} 46'.2$ —SCH.] |
| 6 | 1881, May 12, 13, 14.      | 16 28.4    | Wm. Eimbeck, asst. Coast and Geodetic Survey; about 25 metres S. E. of astronomical station, Temple square. Reference as above.                                                                                    |
| 7 | 1883, November 15, 16, 17. | 16 14.1    | Wm. Eimbeck, asst. Coast and Geodetic Survey, and G. F. Bird, aid; station as above. MS. in archives.                                                                                                              |
| 8 | 1884, October 22, 23, 24.  | 16 13.6    | Observer, locality, and reference as above.                                                                                                                                                                        |
| 9 | 1885, November 5-10.       | 16 29.3 E. | Observer, locality, and reference as above.                                                                                                                                                                        |

## 12.—CAPE MENDOCINO, CAL.

 $\phi=40^{\circ} 26'.3$        $\lambda=124^{\circ} 24'.3$  W. of Gr.

(Light-House.)

|   |                       |          |                                                                                                                                                                                                                                                                                                                                                       |
|---|-----------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1579 (?)--            | 9 E.     | Sir Francis Drake; on a map by Dudley, preserved by Petrus Koerius, dated 1646, showing the coast of New Albion, discovered by Sir F. Drake in 1579. Narrative and critical history of America, Justin Winsor, vol. 2. Boston and New York, 1886. [The compass is $1\frac{1}{2}^{\circ}$ south of Cape Mendocino; not used—SCH.]                      |
|   | 1693--                | 2        | G. F. G. Carreri, Giro del Mondo, Napoli, 1699; see also Hansteen's Magnetismus der Erde, 1819; in $\phi=40^{\circ} 29'$ , $\lambda=124^{\circ} 29'$ W. [Result probably many degrees in error; the narrative states the pilots could give no reason for this strange result; not used—SCH.]*                                                         |
| 1 | 1783. 3.              | 14 10    | Deduced from 122 observations by Spanish navigators along the coast between San Blas and Nootka; see preceding investigation.                                                                                                                                                                                                                         |
| 2 | 1786, September 7, 8. | 14 54    | La Perouse (J. F. G. de); Voyage autour du monde, Paris, 1797, vol. III, pp. 302, 390. On board the Boussole, in $\phi=40^{\circ} 21'$ , $\lambda=124^{\circ} 36'$ W., average declination $=-14^{\circ} 59'$ ; on board the Astrolabe, about the same position, declination $=-14^{\circ} 48'$ . Communicated by Mr. Marcus Baker.                   |
| 3 | 1792, April 18.       | 16 00    | Capt. G. Vancouver; near the cape, about ten leagues from it, it bore N. $36^{\circ}$ W. Vancouver's Voyage of Discovery, etc., 1790-'95, London 1798, vol. 1, p. 197. [This would put him in about $\phi=39^{\circ} 58'$ , $\lambda=124^{\circ} 12'$ W., probable reduction to the Cape $-0^{\circ}.25$ , hence declination $=-16^{\circ}.25$ —SCH.] |
|   | 1792, April 19.       | 15 00    | Same authority, vol. 1, p. 198, on board ship in $\phi=40^{\circ} 03'$ , $\lambda=124^{\circ} 09'$ W. Cape Mendocino bore N. $2^{\circ}$ W. four leagues from shore. [Probable reduction to Cape $-0^{\circ}.20$ , hence declination $=-15^{\circ}.20$ —SCH.]                                                                                         |
|   | 1792, April 22.       | 16 00 E. | Same authority, vol. 1, p. 200. In $\phi=40^{\circ} 32'$ , $\lambda=124^{\circ} 32'$ W. [Probable reduction to cape $+0^{\circ}.10$ , declination $=-15^{\circ}.90$ ; mean of three values $=-15^{\circ}.78$ —SCH.]                                                                                                                                   |

\* This navigator probably refers to False Cape Mendocino, as we may infer from his latitude. This latter cape is now called Cape Fortunas, and is in  $\phi=40^{\circ} 30'.5$ ,  $\lambda=124^{\circ} 22'.8$  W.--SCH.

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## CAPE MENDOCINO, CAL.—Continued.

|   |                          |                 |                                                                                                                                                                                                                                                                                   |
|---|--------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | 1794, October 3.         | ° /<br>14 00 E. | Same authority, vol. III, p. 321. In $\phi = 40^{\circ} 42'$ , $\lambda = 124^{\circ} 30'$ W. [Probable reduction to cape $+ 0^{\circ}.12$ , declination $= - 13^{\circ}.88$ —SCH.]                                                                                               |
| 5 | 1854, April 25 to May 2. | 17 04.5         | G. Davidson, asst. Coast Survey; at Humboldt astronomical station in $\phi = 40^{\circ} 44'.7$ , $\lambda = 124^{\circ} 12'.8$ W. Coast and Geodetic Survey Report for 1881, App. 9. [Probable reduction to cape $+ 0^{\circ}.15$ . Hence declination $= - 16^{\circ} 56'$ —SCH.] |
| 6 | 1886, April 7, 8, 9, 10. | 18 00.5 E.      | G. Davidson, asst. Coast and Geodetic Survey, and F. Morse, aid; near the light-house in $\phi = 40^{\circ} 26'.3$ , $\lambda = 124^{\circ} 24'.3$ W. MS. in archives.                                                                                                            |

## 13.—VANCOUVER, WASH. T.

 $\phi = 45^{\circ} 37'.5$        $\lambda = 122^{\circ} 39'.7$  W. of Gr.

(Flag-staff of Fort Vancouver.)

|   |                       |                 |                                                                                                                                                                                                                                                                                                                                                                                  |
|---|-----------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1788, August 14.      | ° /<br>14 26 E. | Gray; Haswell's narrative, communicated by Asst. G. Davidson; in $\phi = 45^{\circ} 27'$ , $\lambda = 122^{\circ} 19'$ W. [Probable reduction to Vancouver $- 8'$ , hence declination $= - 14^{\circ} 34'$ ; the weight one-half is given to this result. The formula established for stations on the coast and epoch 1783.3 would give for this place $- 16^{\circ} 00'$ —SCH.] |
| 2 | 1839..                | 19 22           | Sir Edw. Belcher; Phil. Trans. Roy. Soc., 1841; in $\phi = 45^{\circ} 37'$ , $\lambda = 122^{\circ} 36'$ W.                                                                                                                                                                                                                                                                      |
| 3 | 1859..                | 21 30           | S. Garfield, surveyor-general Washington Territory; MS. communication dated Aug. 24, 1866. [In $\phi = 45^{\circ} 40'$ , $\lambda = 122^{\circ} 38'$ W.—SCH.]                                                                                                                                                                                                                    |
| 4 | 1860..                | 20 05           | Capt. R. W. Haig, English Commissioner of boundary survey. Phil. Trans. Roy. Soc., vol. 154, part II, 1864. In $\phi = 45^{\circ} 38'$ , $\lambda = 122^{\circ} 28'$ W.                                                                                                                                                                                                          |
| 5 | 1881, October 26, 27. | 20 53.3 E.      | J. S. Lawson, asst. Coast and Geodetic Survey; south of Old Fort in $\phi = 45^{\circ} 37'.5$ , $\lambda = 122^{\circ} 39'$ W. Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                                                |

## 14.—WALLULA, WASH. T.

 $\phi = 46^{\circ} 05'$        $\lambda = 118^{\circ} 55'$  W. of Gr.

(Magnetic station of 1861.)

|   |        |                 |                                                                                                                                                                                                                           |
|---|--------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1853.. | ° /<br>19 40 E. | Governor I. I. Stevens; North Pacific Railroad Explorations, at old Fort Walla Walla, in $\phi = 46^{\circ} 04'$ , $\lambda = 118^{\circ} 48'$ W. Coast Survey Report for 1856, p. 223.                                   |
|   | 1860.. | 20 30           | S. Garfield, surveyor-general of Washington Territory. In town Walla Walla, or near new Fort Walla Walla, in $\phi = 46^{\circ} 03'$ , $\lambda = 118^{\circ} 20'$ W. MS. communication of Aug. 24, 1866. [Not used—SCH.] |
| 2 | 1860.. | 20 00 E.        | Capt. J. Mullan, U. S. A.; "Magnetic Variation," by J. B. Stone, New York, 1878. In $\phi = 46^{\circ} 03'$ , $\lambda = 118^{\circ} 24'$ W.; in town Walla Walla, near new fort.                                         |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## WALLULA, WASH. T.—Continued.

|   |                                          |                     |                                                                                                                                                                                                                                                                                                                                                                                                             |
|---|------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 | 1861--<br>1881, September 24, 25, 26.    | 20 30 E.<br>22 04.4 | S. Garfielde, surveyor-general Washington Territory; at Wallula, or old Fort Walla Walla. [In $\phi=46^{\circ} 05'$ , $\lambda=118^{\circ} 55'$ W.—SCH.]<br>J. S. Lawson, asst. Coast and Geodetic Survey; town of Walla Walla, in $\phi=46^{\circ} 03'.9$ , $\lambda=118^{\circ} 20'.5$ W. Coast and Geodetic Survey Report for 1881, App. 9. [Supposed to be affected by local deflection; not used—SCH.] |
| 4 | 1881, September 29, 30,<br>October 1, 2. | 19 55.7 E.          | J. S. Lawson, asst. Coast and Geodetic Survey, at Wallula, near and north of old fort, in $\phi=46^{\circ} 07'$ , $\lambda=118^{\circ} 55'$ W. Reference as above.                                                                                                                                                                                                                                          |

## 15.—CAPE DISAPPOINTMENT, WASH. T.

 $\phi=46^{\circ} 16'.7$        $\lambda=124^{\circ} 02'.8$  W. of Gr.

(South shore of Baker's Bay.)

|   |                       |            |                                                                                                                                                                                                                                                                                                                                                                           |
|---|-----------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1783. 3.              | 16 23 E.   | Deduced from 122 observations by Spanish navigators along the coast between San Blas and Nootka; see preceding investigation.                                                                                                                                                                                                                                             |
| 2 | 1786, September 1, 2. | 18 0       | La Perouse (J. F. G. de); observed on board the Boussole, Sept. 1, in $\phi=46^{\circ} 39'$ , $\lambda=124^{\circ} 17'$ W., declination $=-18^{\circ} 53'$ ; and Sept. 2, in $\phi=45^{\circ} 57'$ , $\lambda=124^{\circ} 10'$ W., declination $=-17^{\circ} 07'$ . Voyage autour du Monde, etc., Paris, 1797, vol. iii, pp. 300, 303, 388; communicated by Mr. M. Baker. |
| 3 | 1792, April 27.       | 18 0       | Capt. G. Vancouver; on board ship; in $\phi=46^{\circ} 14'$ , $\lambda=123^{\circ} 59'$ W., near mouth of Columbia River; Hansteen's Magnetismus der Erde, 1819.                                                                                                                                                                                                          |
| 4 | 1839--                | 19 11      | Sir Edw. Belcher, in Baker's Bay, $\phi=40^{\circ} 17'$ , $\lambda=124^{\circ} 02'$ W.; Phil. Trans. Roy. Soc., 1841.                                                                                                                                                                                                                                                     |
| 5 | 1842--                | 20 00      | Duflot de Mofras; Exploration of Oregon, Paris, 1844; at mouth of Columbia River.                                                                                                                                                                                                                                                                                         |
| 6 | 1851, July 5-9.       | 20 19.1    | G. Davidson, asst. Coast Survey; near beach of Baker's Bay, Cape Disappointment, in $\phi=46^{\circ} 16'.7$ , $\lambda=124^{\circ} 02'.8$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                          |
|   | 1851, July 14-19.     | 20 45.3    | Observer and reference as above; on top of cape at astronomical station, in $\phi=46^{\circ} 16'.6$ , $\lambda=124^{\circ} 03'.0$ W. [Not used—SCH.]                                                                                                                                                                                                                      |
| 7 | 1858--                | 21 00      | Communication by S. Garfielde, surveyor-general Washington Territory, dated Aug. 24, 1866.                                                                                                                                                                                                                                                                                |
| 8 | 1873, October 24-27.  | 21 26.5    | Wm. Eimbeck, asst. Coast Survey; near beach of Baker's Bay, in $\phi=46^{\circ} 16'.7$ , $\lambda=124^{\circ} 02'.8$ W.; Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                                               |
|   | 1873, October 19-23.  | 21 46.9    | Observer and reference as before; on top of cape at old astronomical station. [Not used—SCH.]                                                                                                                                                                                                                                                                             |
| 9 | 1881, October 14.     | 21 36.0 E. | H. E. Nichols, Lt. Comdr. U. S. N.; asst. Coast and Geodetic Survey; near beach.                                                                                                                                                                                                                                                                                          |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## OLYMPIA, WASH. T.

 $\phi = 47^{\circ} 02'$        $\lambda = 122^{\circ} 54'$  W. of Gr.

|   |                         |            |                                                                                                                                                                                                                                                                                           |
|---|-------------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1783. 3.                | 16 35 E.   | Deduced from 122 observations by Spanish navigators along the coast between San Blas and Nootka; see preceding investigation.                                                                                                                                                             |
| 2 | 1853..                  | 21 15      | S. Garfielde, surveyor-general Washington Territory; in $\phi = 47^{\circ} 03'$ , $\lambda = 122^{\circ} 54'$ W.; MS. communication to office of Aug. 24, 1866.                                                                                                                           |
| 3 | 1856. 5.                | 20 47      | Sir Edw. Sabine; Phil. Trans. Roy. Soc., 1872, communication XIII; in $\phi = 47^{\circ} 03'$ , $\lambda = 122^{\circ} 55'$ W. [Compared with observations made at Steilacoom this value seems too small—SCH.]                                                                            |
| 4 | 1881, November 2, 3, 4. | 21 34.6 E. | J. S. Lawson, asst. Coast Survey; near Eleventh and Main streets, in $\phi = 47^{\circ} 02'.3$ , $\lambda = 122^{\circ} 54'.0$ W.; Coast and Geodetic Survey Report for 1881, App. 9.<br>[The above observations are insufficient to deduce a satisfactory value for secular change—SCH.] |

## 16.—SEATTLE, DUWAMISH BAY, WASH. T.

 $\phi = 47^{\circ} 35'.9$        $\lambda = 122^{\circ} 20'.0$  W. of Gr.

(Astronomical station of 1871.)

|   |                               |            |                                                                                                                                                                                                      |
|---|-------------------------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1783. 3.                      | 16 45 E.   | Deduced from 122 observations by Spanish navigators along the coast between San Blas and Nootka; see preceding investigation.                                                                        |
| 2 | 1855..                        | 21 25      | S. Garfielde, surveyor-general of Washington Terr'y. MS. communication dated Aug. 24, 1866. [In $\phi = 47^{\circ} 36'$ , $\lambda = 122^{\circ} 20'$ W.—SCH.]                                       |
| 3 | 1871, September 27–October 3. | 22 35.4    | S. R. Throckmorton, aid Coast Survey; in $\phi = 47^{\circ} 35'.9$ , $\lambda = 122^{\circ} 20'.0$ W. Coast and Geodetic Survey Report for 1881, App. 9. [Result depends on a doubtful azimuth—SCH.] |
| 4 | 1881, November 8–11..         | 22 02.5 E. | J. S. Lawson, asst. Coast and Geodetic Survey; station near that of 1871. Lat. and long. as above. Coast and Geodetic Survey Report for 1881, App. 9.                                                |

## 17.—PORT TOWNSEND, WASH. T.

 $\phi = 48^{\circ} 07'.0$        $\lambda = 122^{\circ} 44'.9$  W. of Gr.

(Station Point Hudson.)

|   |                     |          |                                                                                                                                                                                                                                                               |
|---|---------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1783. 3.            | 17 00 E. | Deduced from 122 observations of Spanish navigators along the coast between San Blas and Nootka; see preceding investigation.                                                                                                                                 |
|   | 1792, May.          | 21 30    | Capt. G. Vancouver; at Port Discovery, in $\phi = 48^{\circ} 02'$ , $\lambda = 122^{\circ} 38'$ W. Hansteen's <i>Magnetismus der Erde</i> , 1819. [Apparently about $3^{\circ}$ too great, not used—SCH.]                                                     |
| 2 | 1841..              | 20 40    | Chart by U. S. Exploring Expedition, Commander Wilkes, at Carr Point, in $\phi = 48^{\circ} 03'.3$ , $\lambda = 122^{\circ} 50'.8$ W.                                                                                                                         |
| 3 | 1856, August 17–20. | 21 39.5  | G. Davidson, asst. Coast Survey; at Point Hudson, in $\phi = 48^{\circ} 07'.0$ , $\lambda = 122^{\circ} 44'.9$ W. Coast and Geodetic Survey Report for 1881, App. 9.                                                                                          |
| 4 | 1857..              | 21 54 E. | S. Garfielde, surveyor-general Washington Terr'y, at Admiralty Head, Whidbey Island, in $\phi = 48^{\circ} 09'$ , $\lambda = 122^{\circ} 41'$ W. Letter to office, dated Aug. 24, 1866. [Reduction to Port Townsend $+8'$ , decl'n $= -21^{\circ} 46'$ —SCH.] |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## PORT TOWNSEND, WASH. T.—Continued.

|   |                            |         |    |                                                                                                                                                                                                                 |
|---|----------------------------|---------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1859..                     | 20 45   | E. | Reference as above; in $\phi = 48^{\circ} 07'$ , $\lambda = 122^{\circ} 45'$ W. [Not used—SCH.]                                                                                                                 |
| 5 | 1862..                     | 22 00   |    | Reference as above; in $\phi = 48^{\circ} 01'$ , $\lambda = 121^{\circ} 51'$ W., at mill.                                                                                                                       |
| 6 | 1876, February.            | 21 59   |    | Capt. G. H. Burden, U. S. A. Report of Chief of Engineers, U. S. A., 1876, p. 3.                                                                                                                                |
| 7 | 1881, November 16, 17, 18. | 21 26.9 | E. | J. S. Lawson, asst. Coast and Geodetic Survey. Astronomical station of 1852 at Point Hudson, in $\phi = 48^{\circ} 07'.0$ , $\lambda = 122^{\circ} 45'.0$ W. Coast and Geodetic Survey Report for 1881, App. 9. |

## 18.—NEE-AH BAY, CAPE FLATTERY, WASH. T.

 $\phi = 48^{\circ} 21'.8$        $\lambda = 124^{\circ} 38'.0$  W. of Gr.

(Astronomical station, Scarboro' Harbor.)

|   |                     |         |    |                                                                                                                                                                                                                                |
|---|---------------------|---------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1783. 3.            | 17 15   | E. | Deduced from 122 observations by Spanish navigators along the coast between San Blas and Nootka; see preceding investigation.                                                                                                  |
| 2 | 1792, April 30.     | 18 00   |    | Capt. G. Vancouver; inside Cape Flattery, in $\phi = 48^{\circ} 19'$ , $\lambda = 123^{\circ} 41'$ W. [Supposed misprint for $124^{\circ} 31'$ —SCH.] Hansteen's <i>Magnetismus der Erde</i> , 1819.                           |
| 3 | 1841..              | 22 30   |    | Chart of U. S. Exploring Expedition, Commander Wilkes; at Scarborough harbor, north point of Nee-ah Island, in $\phi = 48^{\circ} 21'.8$ , $\lambda = 124^{\circ} 38'.0$ W. [Weight $\frac{1}{4}$ assigned to this value—SCH.] |
| 4 | 1852, August 17–23. | 21 29.9 |    | G. Davidson, asst. Coast Survey, and J. Rockwell, aid; at Scarboro' harbor astronomical station, in $\phi = 48^{\circ} 21'.8$ , $\lambda = 124^{\circ} 38'.0$ W. Coast and Geodetic Survey Report for 1881, App. 9.            |
| 5 | 1855, August 13–18. | 21 48.2 |    | Lieut. W. P. Trowbridge, asst. Coast Survey; Nee-ah Bay, near Waaddah Island, in $\phi = 48^{\circ} 22'$ , $\lambda = 124^{\circ} 36'.8$ W. Reference as above.                                                                |
| 6 | 1881, October 11.   | 22 44.2 | E. | H. E. Nichols, Lt. Comdr. U. S. N., asst. Coast and Geodetic Survey; near station of 1855. Reference as above.                                                                                                                 |

## 19.—NOOTKA SOUND, VANCOUVER ISLAND.

 $\phi = 49^{\circ} 35'.5$        $\lambda = 126^{\circ} 37'.5$  W. of Gr.

(Friendly Cove.)

|   |                      |       |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---|----------------------|-------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1778, April 4.       | 19 45 | E. | Capt. Cook; in Resolution Cove, $\phi = 49^{\circ} 35'$ , $\lambda = 126^{\circ} 37'$ W. Hansteen's <i>Magnetismus der Erde</i> , 1819; also <i>Encyclopædia Metropolitana</i> , 1848. [Cook notes large local attractions on shore at Ship Cove, vol. ii, p. 338, of his <i>Voyage to the Pacific</i> , London, 1784; the value here given was observed on board ship—SCH.]                                                                                                                                                                                       |
| 2 | 1783. 3.             | 17 54 |    | Deduced from 122 observations by Spanish navigators along the coast between San Blas and Nootka; see preceding investigation.                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 3 | 1786, August 25, 26. | 19 47 | E. | La Perouse (J. F. G. de); <i>Voyage autour du monde</i> , etc., Paris, 1797, vol. iii, pp. 300, 310, and 388. Observed about ten miles off shore, on board the <i>Astrolabe</i> , in average $\phi = 49^{\circ} 39'$ , and average $\lambda = 128^{\circ} 39'$ W., declination = $-19^{\circ} 47'$ . On board the <i>Boussole</i> in average $\phi = 49^{\circ} 37'$ , average $\lambda = 127^{\circ} 22'$ W., declination = $-23^{\circ} 14'$ . Communication by Mr. M. Baker, Coast and Geodetic Survey. [The observations on the <i>Boussole</i> not used—SCH.] |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## NOOTKA SOUND, VANCOUVER ISLAND—Continued.

|   |                                   |            |                                                                                                                                                                                                                                                     |
|---|-----------------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1791, August 16, 17, September 4. | 22 30 E.   | Don A. Malaspina; observed on shore; Berliner Astron. Jahrbuch, vol. 53, for 1828. Position on Sept. 4, 1791, in $\phi=49^{\circ} 57'$ , $\lambda=126^{\circ} 19' W.$ Et. Marchand's Voyage autour du Monde, Paris, an vii, vol. 2. [Not used—SCH.] |
| 4 | 1792, October.                    | 18 22      | Capt. G. Vancouver; in Nootka Sound, $\phi=49^{\circ} 34'$ , $\lambda=126^{\circ} 28' W.$ Hansteen's Magnetismus der Erde, 1819.                                                                                                                    |
| 5 | 1860--                            | 23 47      | G. H. Richards, Capt. R. N., in Friendly Cove, in $\phi=49^{\circ} 35'.5$ , $\lambda=126^{\circ} 37'.5 W.$ Vancouver Island Pilot, Admiralty, London, 1864.                                                                                         |
| 6 | 1863--                            | 23 05      | Observer and locality as above; Admiralty chart of Nootka Sound, No. 1916, 1865. Note: Magnetic variation increasing about 2' annually.                                                                                                             |
| 7 | 1881, September 27.               | 23 36.2 E. | H. E. Nichols, Lt. Comdr. U. S. N., asst. Coast and Geodetic Survey; at Friendly Cove. Coast and Geodetic Survey Report for 1881, App. 9. [Double weight has been given to this observation—SCH.]                                                   |

## 20.—SITKA, ALASKA.

 $\phi=57^{\circ} 02'.9$        $\lambda=135^{\circ} 19'.7 W.$  of Gr.

(Parade grounds, Sitka.)

|   |                         |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---|-------------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1775, August 23.        | 22 E.    | Don Bruno de Heceta; in $\phi=57^{\circ} 08'$ , $\lambda=140^{\circ} 44' W.$ ; Coast and Geodetic Survey Report for 1885, App. 7, p. 276; see also F. A. Maurelle, Journal of a voyage to N. W. coast of America, D. Barrington Miscellanies, London, 1781. [At sea, not used—SCH.]                                                                                                                                                                                                                                                              |
| 1 | 1779, July 7.           | 23 30    | San Virey and Antonio Bucareli; in $\phi=56^{\circ} 13'$ , $\lambda=141^{\circ} 52' W.$ ; Coast and Geodetic Survey Report for 1885, App. 7, p. 278.                                                                                                                                                                                                                                                                                                                                                                                             |
| 2 | 1786, August 6, 7.      | 26 46    | La Perouse (J. F. G. de); Voyage autour du monde, Paris, 1797, vol. iii, pp. 296, 299, 386; mean of four determinations, a few leagues off shore. On board the Boussole, declination= $23^{\circ} 28' E.$ , in average $\phi=56^{\circ} 54'$ and average $\lambda=135^{\circ} 26' W.$ ; on board the Astrolabe, about the same positions, declination= $25^{\circ} 04' E.$ [Mean declination= $-26^{\circ} 46'$ used—SCH.] Observations communicated by Mr. Marcus Baker, attached to the Computing Division at the Survey Office in July, 1879. |
| 3 | 1787, June.             | 24 0     | Capt. G. Dixon; Voyage around the world, London, 1789, at anchor near White's Point, $\phi=57^{\circ} 03'$ , $\lambda=135^{\circ} 38' W.$ From compass bearings. Communicated by Mr. M. Baker.                                                                                                                                                                                                                                                                                                                                                   |
| 4 | 1791, August 8, 11, 21. | 27 46    | Capt. E. Marchand; Voyage around the world, London, 1801, two volumes. Mean of three values given in vol. ii. One mile north of Dixon's station, in $\phi=57^{\circ} 04'$ , $\lambda=135^{\circ} 39' W.$ (In volume i the observer gives the declination= $-28^{\circ} 45'$ .) Communicated by Mr. M. Baker.                                                                                                                                                                                                                                     |
| 5 | 1804, August 20.        | 26 45    | Capt. U. Lisiansky; Voyage around the world, London, 1814. In $\phi=57^{\circ} 03'$ , $\lambda=135^{\circ} 30' W.$                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 6 | 1818, July.             | 27 15    | Capt. V. M. Golovnin; Voyage around the world, St. Petersburg, 1822, vol. ii. Mean of several observations between $-24^{\circ}$ and $-30\frac{1}{2}^{\circ}$ . In $\phi=57^{\circ} 02'.8$ , $\lambda=135^{\circ} 06'.6 W.$ Communicated by Mr. M. Baker.                                                                                                                                                                                                                                                                                        |
| 7 | 1824, August.           | 27 30 E. | Capt. Otto von Kotzebue; New voyage around the world, 1823-26, London, 1830, vol. ii, pp. 66, 77; see also Becquerel's Traité du Magnétisme, Paris, 1846. In $\phi=57^{\circ} 02'.9$ , $\lambda=135^{\circ} 33'.3 W.$                                                                                                                                                                                                                                                                                                                            |

## GROUP III.—Series of Magnetic Stations mainly on the Pacific Coast, etc.—Continued.

## SITKA, ALASKA—Continued.

|    |                                                           |          |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----|-----------------------------------------------------------|----------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8  | 1827. 5.                                                  | 28 50    | E. | Capt. F. P. Lütke. Gen'l Sir Edw. Sabine's Conts. to Terr. Mag., No. xiii, Phil. Trans. Roy. Soc., 1872. In $\phi=57^{\circ} 03'$ , $\lambda=135^{\circ} 23' W$ .                                                                                                                                                                                                                                                                                      |
| 9  | 1829, November 10.                                        | 28 18. 8 |    | Ad. Erman; Reise um die Welt, Berlin, 1835, vols. i and ii; a careful determination on shore, in a place behind the church, in $\phi=57^{\circ} 02'.7$ , $\lambda=135^{\circ} 25'.5 W$ .                                                                                                                                                                                                                                                               |
| 10 | 1837, September 12–16.                                    | 27 42    |    | Sir Edw. Belcher; a careful determination on shore near the Governor's house, in $\phi=57^{\circ} 03'$ , $\lambda=135^{\circ} 26' W$ . Sir Edw. Sabine; in Phil. Trans. Roy. Soc., 1841, part i.                                                                                                                                                                                                                                                       |
|    | 1839, July 15–19.                                         | 29 32. 5 |    | Sir Edw. Belcher; a careful determination at summer-house in the Governor's garden, in $\phi=57^{\circ} 03'$ , $\lambda=135^{\circ} 22' W$ . Sir Edw. Sabine; in Phil. Trans. Roy. Soc., 1843, part i. [Mean of these two values, or— $28^{\circ} 37'$ , used for epoch 1838.6—SCH.]                                                                                                                                                                   |
| 11 | 1842, every month, except January, February, and October. | 28 32. 4 |    | At magnetic observatory on Japonski Island, founded in 1842. Hourly observations. In $\phi=57^{\circ} 02'.9$ , $\lambda=135^{\circ} 20'.1 W$ . Annuaire Mét. et Mag. du Corps des Mines de Russie, St. Pétersbourg, 184– to 184–.*                                                                                                                                                                                                                     |
| 12 | 1843, January to December.                                | 28 54. 0 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 13 | 1844, January to December.                                | 28 57. 3 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 14 | 1845, January to December.                                | 29 00. 0 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 15 | 1847, May to December.                                    | 28 58. 9 |    | At magnetic observatory on Japonski Island. Annales de l'observ. phys. central de Russie, St. Pétersbourg, 184– to 185–.                                                                                                                                                                                                                                                                                                                               |
| 16 | 1848, January to December.                                | 29 04. 5 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 17 | 1849, January, February, March.                           | 29 03. 6 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 18 | 1850, January to December.                                | 28 50. 3 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|    | 1851.0.                                                   | 29 14    |    | Capt. Richard Collinson; MS. in Brit. Hyd. Office. Sir Edw. Sabine in Phil. Trans. Roy. Soc., 1872; Conts. to Terr. Mag., No. xiii. [Not used—SCH.]                                                                                                                                                                                                                                                                                                    |
| 19 | 1851, whole year.                                         | 28 53. 1 |    | See differential observations at magnetic observatory, Japonski Island; Comptes Rendus of the Central Physical Observatory of Russia, 1851 to 1864. In 1851–'52–'56 observations during 17 hours each day.                                                                                                                                                                                                                                             |
| 20 | 1852, January to July, November, and December.            | 28 48. 5 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 21 | 1856..                                                    | 28 58. 6 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 22 | 1857, whole year.                                         | 29 07. 2 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 23 | 1858, whole year.                                         | 29 10. 5 |    | Differential observations as above; in 1857–'58–'59–'60–'61–'63–'64 observations during 19 hours each day.                                                                                                                                                                                                                                                                                                                                             |
| 24 | 1859, whole year.                                         | 29 06. 1 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 25 | 1860, whole year.                                         | 29 07. 9 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 26 | 1861..                                                    | 29 04. 1 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 27 | 1862, whole year.                                         | 29 00. 9 |    | Hourly observations in 1862.                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 28 | 1863..                                                    | 29 03. 3 |    | [Mr. Marcus Baker discussed the magnetic observations at Japonski Island made between 1850 and 1864 incl., and as there was no absolute determination for this period, he based his annual mean values on the computed value resulting from my expression of the secular change at Sitka, given in the preceding edition; thus the differential scale reading 396.0 for 1857.5 corresponds to the declination $29^{\circ} 07'.2 E$ , March, 1882—SCH.] |
| 29 | 1864..                                                    | 29 04. 2 |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 30 | 1867, August 17, 18, 19, 20.                              | 28 49    | E. | A. T. Mosman, asst. Coast Survey; at old Russian observatory on Japonski Island, harbor of Sitka, in $\phi=57^{\circ} 02'.9$ , $\lambda=135^{\circ} 20'.1 W$ . Coast Pilot of Alaska by the U. S. Coast Survey, 1869, p. 120.                                                                                                                                                                                                                          |

\*For the collection of the values Nos. 11 to 29 incl., I am indebted to Mr. Marcus Baker, of the Coast Survey, Computing Division, 1879. He discussed the differential hourly observations made at the magnetic observatory between 1842 and 1849, basing the annual means upon the absolute determinations of Jan. 4, 1843, when  $D=28^{\circ} 48'.9 E$ , and of March 4, 1843, when  $D=25^{\circ} 57'.3 E$ . The first value corresponded to scale value 419.3, the second to 432.4 divisions of the differential declinometer—SCH.

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## SITKA, ALASKA—Continued.

|    |                               |            |                                                                                                                                                                                                                         |
|----|-------------------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31 | 1874, May 4, 5.               | 28 59.5 E. | M. Baker, U. S. Coast Survey, W. H. Dall, asst. in charge of party; station on parade ground, in $\phi=57^{\circ} 02'.9$ , $\lambda=135^{\circ} 19'.7$ W. Coast and Geodetic Survey Report for 1881, App. 9.            |
| 32 | 1876, January 15 to March 20. | 28 20.5    | Capt. J. B. Campbell and Lt. W. R. Quinan, U. S. A.; Report of Chief of Engineers 1876, part 3, p. 751.                                                                                                                 |
| 33 | 1879, April.                  | 28 54      | Lieut. J. E. Craig, U. S. S. Alaska; Report to Capt. G. Brown, U. S. N., May 7, 1879, at station of 1874 on parade ground.                                                                                              |
| 34 | 1880, May 17, 18.             | 29 04.8    | M. Baker and W. H. Dall, U. S. Coast and Geodetic Survey; near old Russian observatory, Japonski Island, in $\phi=57^{\circ} 02'.9$ , $\lambda=135^{\circ} 20'.3$ W. Coast and Geodetic Survey Report for 1881, App. 9. |
| 35 | 1881, September 15, 16.       | 29 11.2 E. | H. E. Nichols, Lt. Comdr. U. S. N., asst. Coast and Geodetic Survey; on Japonski Island, station of 1880. Reference as above.                                                                                           |

## 21.—PORT MULGRAVE, YAKUTAT BAY, ALASKA.

 $\phi=59^{\circ} 33'.7$        $\lambda=139^{\circ} 45'.9$  W. of Gr.

|   |                |            |                                                                                                                                                                                                                                                                                                                                                           |
|---|----------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1778, May 6.   | 23 10 E.   | Capt. J. Cook; Voyage to the Pacific Ocean, London, 1784, vol. iii, p. 506. May 6, at sea, off Dry Bank, in $\phi=59^{\circ} 08'$ , $\lambda=139^{\circ} 41'$ W.                                                                                                                                                                                          |
|   | 1778, May 7.   | 24 26      | May 7, at sea, near coast south of Mt. St. Elias, in $\phi=59^{\circ} 27'.5$ , $\lambda=140^{\circ} 53'$ W. Communicated by Mr. M. Baker, Coast and Geodetic Survey. [Taking mean values we have for $\phi=59^{\circ} 18'$ , $\lambda=140^{\circ} 17'$ W., the declination $=-23^{\circ}.80$ for 1778.3; the weight one-half is given to this value—SCH.] |
| 2 | 1787, May.     | 26 00      | Capt. G. Dixon; Voyage round the World, London, 1789.                                                                                                                                                                                                                                                                                                     |
| 3 | 1791, July 1.  | 26 40      | Don A. Malaspina; Bode's Berliner Jahrbuch for 1828; also Espinoza Memorias, 2 vols., Madrid, 1803. On shore in $\phi=59^{\circ} 33'.7$ , $\lambda=139^{\circ} 46'.3$ W.                                                                                                                                                                                  |
| 4 | 1794, July.    | 26 00      | Capt. G. Vancouver; A Voyage of Discovery, 1790-'95, London, 1798. At Port Mulgrave, Lieut. Puget, observer, with ship's compass. Communicated by Mr. M. Baker.                                                                                                                                                                                           |
| 5 | 1802 (about).  | 29 00      | Old Russian chart without date or author; at New Russia Harbor, settled 1795 and destroyed 1803; in $\phi=59^{\circ} 31'$ , $\lambda=139^{\circ} 36'.5$ W. Communicated by Mr. M. Baker.                                                                                                                                                                  |
| 6 | 1823...        | 30 30      | Lieut. Khromchenko, on Russian Hydro'c Chart, No. 1378; at end of spit, in $\phi=59^{\circ} 33'.6$ , $\lambda=139^{\circ} 46'.5$ W.                                                                                                                                                                                                                       |
| 7 | 1874, May 22.  | 29 58.3    | M. Baker, U. S. Coast Survey, W. H. Dall, chief of party. Coast and Geodetic Survey Report for 1881, App. 9.                                                                                                                                                                                                                                              |
| 8 | 1880, June 24. | 29 59.8 E. | Observer and reference as above. At Yakutat Bay.                                                                                                                                                                                                                                                                                                          |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## 22.—PORT ETCHES, PRINCE WILLIAM SOUND, ALASKA.

 $\phi = 60^{\circ} 20'.7$        $\lambda = 146^{\circ} 37'.6$  W. of Gr.

(Astronomical station of 1874.)

|   |                     |         |    |                                                                                                                                                                                                                                                                                  |
|---|---------------------|---------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1778, May 19.       | 23 37   | E. | Capt. J. Cook, Voyage to the Pacific Ocean, 3 vols., London, 1784, vol. iii, p. 507. Communicated by Mr. M. Baker, Coast and Geodetic Survey.                                                                                                                                    |
| 2 | 1787, May.          | 26 00   |    | Portlock; Voyage, &c., London, 1789; at Chalmers's Harbor, in $\phi = 60^{\circ} 17'$ , $\lambda = 147^{\circ} 27'$ W. Communicated by Mr. M. Baker.                                                                                                                             |
|   | 1787, May and July. | 26 30   |    | Observer and reference as above. At Port Etches, Garden Cove, in $\phi = 60^{\circ} 20'.5$ , $\lambda = 145^{\circ} 45'$ W.; maps, pp. 215 and 216. Communicated by Mr. M. Baker.                                                                                                |
|   | 1787..              | 27 00   |    | James Johnstone, Dalrymple's charts, at Cape Hinchinbrock, in $\phi = 60^{\circ} 18'$ , $\lambda = 147^{\circ} 01'$ W. Comm'd by Mr. M. Baker. [Not used—SCH.]                                                                                                                   |
| 3 | 1788, May 17.       | 25 00   |    | Don Estaban Martinez, in the Princessa. In $\phi = 60^{\circ} 10'$ , $\lambda = 147^{\circ} 35'$ W. Coast and Geodetic Survey Report for 1885, App. 7, p. 281.                                                                                                                   |
| 4 | 1790..              | 26 28   |    | Nuchek, Constantine Redoubt. Sarycheff, old Russian chart without date or number; in $\phi = 60^{\circ} 18'$ , $\lambda = 146^{\circ} 32'$ W. Communicated by Mr. M. Baker.                                                                                                      |
|   | 1790, May 23.       | 26 00   |    | Fidalgo, in the packet Philipino. In $\phi = 60^{\circ} 12'$ , $\lambda = 146^{\circ} 31'$ W. Coast and Geodetic Survey Report for 1885, App. 7, p. 283. [Mean value = $-26^{\circ} 14'$ used in discussion—SCH.]                                                                |
|   | 1790, July 30.      | 28 30   |    | Commodore J. Billings; M. Sauer, Account of a Geographical and Astronomical Expedition, London, 1802, p. 200. Communicated by Mr. M. Baker. [Not used—SCH.]                                                                                                                      |
| 5 | 1794, June.         | 28 30   |    | Capt. G. Vancouver; Voyage round the World, London, 1798, vol. iii, p. 188; at Port Chalmers, in $\phi = 60^{\circ} 16'$ , $\lambda = 146^{\circ} 38'$ W. Observed 30 sets with 4 compasses, ranging from $-26^{\circ} 50'$ to $-30^{\circ} 09'$ . Communicated by Mr. M. Baker. |
| 6 | 1810 (?)            | 28 07.5 |    | Nuchek; Sarycheff, old Russian chart No. xvii; in $\phi = 60^{\circ} 17'.5$ , $\lambda = 147^{\circ} 00'$ W. Communicated by Mr. M. Baker.                                                                                                                                       |
| 7 | 1830..              | 31 38   |    | Nuchek, Constantine Redoubt. Chernoff, Russian Hydr'c Chart No. 1378, published in 1847. In $\phi = 60^{\circ} 20'$ , $\lambda = 146^{\circ} 32'.5$ W.                                                                                                                           |
| 8 | 1837, Aug. 27.      | 31 38   |    | Sir Edw. Belcher, on beach near Phipp's Point, Port Etches. Sir Edw. Sabine, in Phil. Trans. Roy. Soc., 1843, part 2, and Contributions xiii, 1872; in $\phi = 60^{\circ} 21'$ , $\lambda = 146^{\circ} 41'$ W.                                                                  |
| 9 | 1874, May 31.       | 29 09.8 | E. | Marcus Baker, U. S. Coast Survey (W. H. Dall, chief of party); at Port Etches, on beach near Phipp's Point. Geographical position as in heading. Coast and Geodetic Survey Report for 1881, App. 9.                                                                              |

## 23.—ST. PAUL, KADIAK ISLAND, ALASKA.

 $\phi = 57^{\circ} 48'.0$        $\lambda = 152^{\circ} 21'.3$  W. of Gr.

(Astronomical Station of 1867.)

|   |                |       |    |                                                                                                                                                                                                                                                                                                                                                                    |
|---|----------------|-------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1778, May 21.  | 23 42 | E. | Capt. J. Cook; Voyage to the Pacific Ocean, London, 1784, vol. ii, pp. 507-8. At sea off Pye Islands in $\phi = 59^{\circ} 30'.3$ , $\lambda = 149^{\circ} 54'$ W.                                                                                                                                                                                                 |
|   | 1778, June 13. | 20 31 | E. | Same observer and reference; at sea off S. W. end of Kadiak in $\phi = 56^{\circ} 49'$ , $\lambda = 154^{\circ} 20'$ W. Communicated by Mr. M. Baker, C. and G. Survey. [Taking mean values we have for $\phi = 58^{\circ} 10'$ , $\lambda = 152^{\circ} 07'$ W., the value $-22^{\circ} 06'$ for epoch 1778.4. The weight one-half was given to this result—SCH.] |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## ST. PAUL, KADIAK ISLAND, ALASKA—Continued.

|    |                          |                |    |                                                                                                                                                                                                                                                                  |
|----|--------------------------|----------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | 1779, August 9.          | 27 0           | E. | San Virey and Antonio Bucareli. At sea in $\phi = 57^{\circ} 59'$ , $\lambda = 152^{\circ} 07' W.$ Coast and Geodetic Survey Report for 1885, App. 7, p. 278. [Not used—SCH.]                                                                                    |
| 2  | 1790--<br>1790, July 10. | 25 30<br>22 10 |    | Sarycheff, old Russian chart, no date.<br>Fidalgo, in packet Philipino; in $\phi = 58^{\circ} 10'$ , $\lambda = 152^{\circ} 07' W.$ Camacho Island in sight. Coast and Geodetic Survey Report for 1885, App. 7, p. 283. [Not used—SCH.]                          |
| 3  | 1804, August 16.         | 26 07          |    | U. Lisiansky; Voyage, etc., London, 1814, p. 365.                                                                                                                                                                                                                |
| 4  | 1808--<br>1808--         | 26 00<br>25 30 |    | { Russian Naval Officer; old Russian chart, sheet No. xvi. In $\phi = 57^{\circ} 47'.2$ ,<br>$\lambda = 152^{\circ} 18'.3 W.$ Communicated by Mr. M. Baker. [The mean decli-<br>nation = $-25^{\circ} 45'$ will be used in the discussion—SCH.]                  |
| 5  | 1818, July 19.           | 26 30          |    | Golovnin (V. M.); Voyage, etc., St. Petersburg, 1822, vol. 2, p. 59. At St. Paul Harbor in front of Governor's house on hill, in $\phi = 57^{\circ} 47'.2$ , $\lambda = 152^{\circ} 18'.3 W.$ Communicated by Mr. M. Baker.                                      |
| 6  | 1834--                   | 28 38          |    | Murasheff; at St. Paul's Harbor. Russian Hydr'c chart, No. 1425. Communicated by Mr. M. Baker.                                                                                                                                                                   |
| 7  | 1839, July.              | 26 43          |    | Sir Edw. Belcher, near Cape Greville, in $\phi = 57^{\circ} 20'$ , $\lambda = 152^{\circ} 51' W.$ Phil. Trans. Roy. Soc., 1843, part ii.                                                                                                                         |
| 8  | 1845 (?)                 | 27 00          |    | Vasilieff; Tebenko's Atlas, xxiii. St. Paul's Harbor. Communicated by Mr. M. Baker.                                                                                                                                                                              |
| 9  | 1867, August 28, 29.     | 26 05          |    | A. T. Mosman, asst. Coast Survey; Harbor of St. Paul at astronomical station on steep rocky bluff about $1\frac{1}{2}$ miles east of village, in $\phi = 57^{\circ} 48'.0$ , $\lambda = 152^{\circ} 21'.4 W.$ Coast and Geodetic Survey Report for 1881, App. 9. |
| 10 | 1874, June 7.            | 25 22          |    | Marcus Baker and W. H. Dall, U. S. Coast Survey; reference as above.                                                                                                                                                                                             |
| 11 | 1880, July 9.            | 25 09.2        | E. | Observers and reference as above; at Chagafka Cove, harbor of St. Paul.                                                                                                                                                                                          |

## 24.—UNALASHKA, CAPTAIN'S AND ILIULIUK HARBORS.

 $\phi = 53^{\circ} 52'.6$        $\lambda = 166^{\circ} 31'.5 W.$  of Gr.

(Greek Church, Iliuliuk Village.)

|   |                   |         |    |                                                                                                                                                                                                                                                                                                         |
|---|-------------------|---------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | 1778, October 12. | 19 59.2 | E. | Capt. J. Cook; Voyage to the Pacific Ocean, London, 1784. Position on shore of Samganuda harbor; in $\phi = 53^{\circ} 55'$ , $\lambda = 166^{\circ} 30' W.$ [Not used—SCH.]                                                                                                                            |
|   | 1789--            | 19 30   |    | John Henry Cox; Dalrymple's charts. Muscle Cove in $\phi = 53^{\circ} 50'$ . Communicated by Mr. Marcus Baker, Computing Division, Coast Survey, 1879. [Not used—SCH.]                                                                                                                                  |
| 1 | 1790, June 4-13.  | 19 35   |    | Commodore J. Billings; M. Sauer, An account of a geographical and astronomical expedition to the northern parts of Russia, London, 1802. On shore of Beaver Bay in $\phi = 53^{\circ} 56'$ , $\lambda = 165^{\circ} 40' W.$ Communicated by Mr. M. Baker. [Weight one-half assigned in discussion—SCH.] |
| 2 | 1792--            | 19 00   |    | Sarycheff; old Russian chart, no date, year doubtful; at Iliuliuk in $\phi = 53^{\circ} 57'$ , $\lambda = 166^{\circ} 32' W.$ Communicated by Mr. W. H. Dall, asst. Coast Survey, Nov., 1873.                                                                                                           |
| 3 | 1817, June.       | 19 24   | E. | Otto von Kotzebue; Voyage of discovery into the South Sea, London, 1821. Iliuliuk Village, in $\phi = 53^{\circ} 52'.4$ , $\lambda = 166^{\circ} 31'.9 W.$ Communicated by Messrs. Dall and Baker, U. S. Coast Survey.                                                                                  |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## UNALASHKA, CAPTAIN'S AND ILIULIUK HARBORS—Continued.

|    |                             |         |    |                                                                                                                                                                                                                                                |
|----|-----------------------------|---------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4  | 1827, August 11.            | 19 50   | E. | Capt. F. P. Lütke; Lenz in Mem. St. Pet. Acad. of Sci., vi série Math. et Phy. Sc., vol. i, 1838. In $\phi = 53^{\circ} 54'$ , $\lambda = 166^{\circ} 30'$ W. Communicated by Mr. M. Baker.                                                    |
|    | 1829.0                      | 19 54   |    | Capt. F. P. Lütke; Gen. Sabine, in Phil. Trans. Roy. Soc., vol. 162, London, 1872. [Supposed to refer to the same observation as above; not used—SCH.]                                                                                         |
| 5  | 1831..                      | 19 30   |    | Vasilieff (?); at sea, north of Akutan. Russian Hydrogr. chart, No. 1379, 1847. In $\phi = 54^{\circ}.4$ , $\lambda = 166^{\circ}.0$ W. Communicated by Mr. M. Baker.                                                                          |
|    | 1848..                      | 19 30.5 |    | Russian Hydrographic Office, chart 8. [Supposed to refer to preceding observation; not used—SCH.]                                                                                                                                              |
| 6  | 1849..                      | 20 00   |    | Tebenkoff's Atlas, chart No. xxv, near church at Iliuliuk in $\phi = 53^{\circ} 52'$ , $\lambda = 165^{\circ} 25'$ W.                                                                                                                          |
| 7  | 1867, September 8, 9.       | 19 47.4 |    | A. T. Mosman, asst. Coast Survey (G. Davidson, chief of party); on shore at Captain's Harbor at Spithead, in $\phi = 53^{\circ} 53'.9$ , $\lambda = 166^{\circ} 30'.4$ W. Coast and Geodetic Survey Report for 1881, App. 9.                   |
| 8  | 1870..                      | 19 45   |    | Kadin; MS. chart of Iliuliuk and Captain's Harbor. Communicated by Mr. W. H. Dall.                                                                                                                                                             |
|    | 1871, November 11.          | 18 36   |    | Dr. W. H. Dall, observer; Amaknak Island, opposite village. [Not used—SCH.]                                                                                                                                                                    |
| 9  | 1873, May 26, 27.           | 19 07.2 |    | Dr. W. H. Dall, observer; near church of Iliuliuk; in $\phi = 53^{\circ} 52'.6$ , $\lambda = 165^{\circ} 31'.6$ W.                                                                                                                             |
|    | 1873, September 17, 18, 19. | 18 59.7 |    | Mr. M. Baker, observer; Amaknak Island, off village in $\phi = 53^{\circ} 52'.9$ , $\lambda = 165^{\circ} 31'.7$ W. Coast and Geodetic Survey Report for 1881, App. 9. [Weighted mean declination— $19^{\circ} 03'.2$ used in discussion—SCH.] |
| 10 | 1874, September 15.         | 18 42.8 |    | Mr. M. Baker, observer. Reference as above.                                                                                                                                                                                                    |
| 11 | 1880, July 23, 27.          | 18 38.0 |    | Messrs. Baker and Dall, Coast and Geodetic Survey, Iliuliuk Harbor; position as in 1873, Amaknak Isd. Reference as before.                                                                                                                     |
| 12 | 1883, September 20, 21.     | 18 42.8 | E. | Mr. R. A. Marr, aid, Coast and Geodetic Survey; at spit in Captain's Harbor. MS. in office.                                                                                                                                                    |

## 25.—PORT CLARENCE, ALASKA.

 $\phi = 65^{\circ} 16'$        $\lambda = 166^{\circ} 50'$  W. of Gr.

(Point Spencer.)

|   |                    |         |    |                                                                                                                                                                                                                                |
|---|--------------------|---------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1827.5.            | 26 55   | E. | Capt. Beechey; Port Clarence and Grantley Bay, in $\phi = 65^{\circ} 17'$ , $\lambda = 166^{\circ} 19'$ W. Sir Edw. Sabine, in Phil. Trans. Roy. Soc., Contribution xiii; 1872.                                                |
| 2 | 1850.5             | 26 26   |    | Captain Kellett. Reference as above.                                                                                                                                                                                           |
| 3 | 1854.5.            | 26 00   |    | Captain Maguire. Reference as above.                                                                                                                                                                                           |
| 4 | 1879, July.        | 23 01.3 |    | Aug. Wykander; Nordenskiöld in the "Vega." Communicated by Mr. W. H. Dall.                                                                                                                                                     |
| 5 | 1880, September 8. | 22 45   | E. | Mr. M. Baker, Coast and Geodetic Survey (W. H. Dall, chief of party); at Port Clarence, near Point Spencer, in $\phi = 65^{\circ} 16'.1$ , $\lambda = 166^{\circ} 50'.6$ W. Coast and Geodetic Survey Report for 1881, App. 9. |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## 26.—CHAMISSO ISLAND, KOTZEBUE SOUND, ALASKA.

 $\phi = 66^{\circ} 13'$        $\lambda = 161^{\circ} 49'$  W. of Gr.

|   |                  |            |                                                                                                                                                                     |
|---|------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1826, August.    | 31 24.3 E. | Capt. F. W. Beechey; Beechey's Narrative of a Voyage to the Pacific 1825-'28, London, 1831. Communicated by Mr. M. Baker.                                           |
|   | 1826.5.          | 31 10      | Brit. Admiralty chart, No. 593. Communicated by Mr. M. Baker.                                                                                                       |
|   | 1826.5.          | 28 53      | Capt. F. W. Beechey. Reference as above. Sir Edw. Sabine's Cont's, xiii, Phil. Trans. Roy. Soc., 1872. [Not used—SCH.]                                              |
| 2 | 1849.5.          | 30 26      | Capt. H. Kellett. Reference as above. In $\phi = 66^{\circ} 16'$ , $\lambda = 161^{\circ} 48'$ W.                                                                   |
| 3 | 1880, August 31. | 26 49 E.   | Mr. M. Baker, Coast and Geodetic Survey (W. H. Dall, in charge of party); at Chamisso Harbor; position $\phi = 66^{\circ} 13'.3$ , $\lambda = 161^{\circ} 48'.7$ W. |

## 27.—PETROPAVLOVSK, KAMTCHATKA, SIBERIA.

 $\phi = 53^{\circ} 01'$        $\lambda = 158^{\circ} 43'$  E. of Gr.

|   |                         |           |                                                                                                                                                                                                                                                                |
|---|-------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1779, June.             | 6 18.7 E. | Capt. J. King; A voyage to the Pacific Ocean, London, 1784. West side of village, in $\phi = 53^{\circ} 00'.6$ , $\lambda = 158^{\circ} 43'.3$ E.                                                                                                              |
| 2 | 1792..                  | 6 00      | G. Sarycheff; F. P. Lütke's Voyage around the world, St. Petersburg, 1835.                                                                                                                                                                                     |
| 3 | 1804, September.        | 5 20      | A. J. von Krusenstern; Voyage round the world, London, 1813. On the spot on which the village stands, in $\phi = 53^{\circ} 00'.2$ , $\lambda = 158^{\circ} 47'.7$ E.                                                                                          |
|   | 1804, September.        | 5 39      | Observer and reference as above. On Avatcha Bay. [Mean value = $5^{\circ}.49$ used in discussion—SCH.]                                                                                                                                                         |
|   | 1809, June 23, July 23. | 7 21      | Capt. Hagemeister; mean value by two compasses. A. G. Erman, Reise um die Erde, Berlin, 1835, vol. ii. Communicated by Mr. M. Baker. [Not used—SCH.]                                                                                                           |
|   | 1825.5.                 | 4 13      | Gen. Sir Edw. Sabine's Cont's to Terr. Mag., No. xiii, in Phil. Trans. Roy. Soc., 1872; in $\phi = 53^{\circ} 00'$ , $\lambda = 158^{\circ} 40'$ E. [This is supposed to refer to Capt. Beechey's observation of 1827; not used—SCH.]                          |
| 4 | 1827, July.             | 4 13.3    | Capt. F. W. Beechey; Narrative of a Voyage to the Pacific, 1825-'28, London, 1831; mean of 9 determinations, in $\phi = 53^{\circ} 01'$ , $\lambda = 158^{\circ} 43'.5$ E.                                                                                     |
|   | 1827, September 30.     | 3 43      | Capt. F. P. Lütke; Lenz in Mem. St. Peters. Acad. Sc., vi, vol. i, 1838; in $\phi = 53^{\circ} 01'$ , $\lambda = 158^{\circ} 44'$ E.                                                                                                                           |
|   | 1827, September 30.     | 4 05.8    | A. G. Erman, Reise um die Erde, Berlin, 1835. In $\phi = 53^{\circ} 00'.5$ , $\lambda = 158^{\circ} 40'$ E. [The mean of the three determinations is used giving the middle one the weight one-half, hence for 1827.6 the declination = $-4^{\circ}.07$ —SCH.] |
|   | 1829.5.                 | 4 04      | Gen. Sir Edw. Sabine's Cont's to Terr. Mag., in Phil. Trans. Roy. Soc., 1872. [This is supposed to refer to Erman's value of 1827; not used—SCH.]                                                                                                              |
| 5 | 1837, September 4.      | 3 27      | Du Petit Thouars; Voyage autour du monde, Paris, 1843. In front of Auchard's house, in $\phi = 53^{\circ} 01'$ , $\lambda = 158^{\circ} 43'$ E.                                                                                                                |
| 6 | 1849.5.                 | 2 37      | Capt. H. Kellett; Gen. Sir Edw. Sabine in Phil. Trans. Roy. Soc., vol. 162, London, 1872.                                                                                                                                                                      |
| 7 | 1854, July.             | 3 40      | Frigate Aurora; Compte-rendu annuel de l'Observatoire Phys. Cent. de Russie, année 1854; St. Pétersbourg, 1855. In $\phi = 53^{\circ} 00'$ , $\lambda = 158^{\circ} 43'.5$ E. [Weight one-half assigned to this value—SCH.]                                    |
|   | 1856, October.          | 3 24 E.   | Admiralty chart, No. 2460; Position of Petropavlovsk in Ency. Brit., 7th edition, $\phi = 53^{\circ} 01'$ , $\lambda = 158^{\circ} 43'$ E. [Supposed to be a computed value; not used—SCH.]                                                                    |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

## PETROPAVLOVSK, KAMTCHATKA, SIBERIA—Continued.

|   |                                  |                   |                                                                                                                                               |
|---|----------------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 8 | 1866--                           | 0 /<br>1 25. 1 E. | K. S. Staritzky; Onazevich's collection of observations made during hydrographic explorations in the Pacific, 1874-'77; St. Petersburg, 1878. |
| 9 | 1876, June 11, 13, September 15. | 1 09 E.           | M. L. Onazevich; Reference as above.                                                                                                          |

N. B.—This important Asiatic station was included in the discussion on account of its proximity to the Western Aleutian or Rat Islands, and as affording the means for connecting the law of secular change with that found to prevail over Siberia. For information No. 3, part of 4 and of Nos. 5, 7, and 9, I am indebted to Mr. Marcus Baker, temporarily (1879) attached to the Computing Division of the Coast and Geodetic Survey Office.

The following two stations on the Sandwich Islands, which were first introduced in the third edition of the paper on the secular change, are here retained, but *without* giving for them an analytical expression of the law of change. This was thought to be the proper course to pursue in view of the uncertainty now attaching to the former values in consequence of later and important information bearing on the subject.

In a letter addressed to me by Curtis J. Lyons, assistant Government Survey, dated Honolulu, January 9, 1884, Mr. Lyons expresses his conviction that from 1850 to 1884 the secular variation was *increasing* the easterly declination prevailing over the Sandwich Islands, and cites his experience on Hawaii, viz: "From a number of compass bearings observed by me in 1853 when compared with the respective bearings taken by the same compass and the same observer in 1872-'73, the increase of declination was 40', hence annual increase 2'.0" Again, in 1873, Mr. Lyons made careful notes of a magnetic bearing of a base line in Oahu and repeated the same with the same instrument in 1884 and found an increase of about 20', hence annual increase 1'.8. He also states that he knows the spot where Commander Wilkes' observatory stood at Honolulu in 1841, and that the old site is now included in the palace yard; at this place he finds the declination in 1884 to be 9° 30' E., hence annual increase 1'.7.

If it thus be a fact that from about the middle of this century to the present time the east declination on the Sandwich Islands has been on the increase, as believed by Mr. Lyons, the explanation might be found in the presence or obtrusion of a secondary wave of sufficient range to have temporarily overpowered and concealed the ordinary effect of the primary wave of secular motion. There certainly was indicated by the observations an increase of east declination from the earliest times for which we have here record up to the year 1832, some years more or less, when apparently a maximum was reached; this last feature it would seem we have now to give up and await further development before we can be certain of our deductions.

In a second letter to me dated Honolulu April 23, 1884, Mr. Lyons gives further evidence supporting his former statements by fresh observational evidence of direct measures, and gives as his result that the annual increase of easterly declination between 1871 and 1884 was about  $\frac{1}{3}$  (1'.9 + 2'.2 + 1'.5) or 1'.9 very nearly.

28.—KAILUA (KAIRUA), HILO AND KEALAKEKUA (KARAKAKOA) BAYS, ISLAND OF HAWAII (OW-HYHEE), SANDWICH ISLANDS.

$$\phi = +19^{\circ} 37' \quad \lambda = 156^{\circ} 01' \text{ W. of Gr.}$$

(Kailua Bay.)

|   |                     |                |                                                                                                                                                                                                                                                                                                              |
|---|---------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1779--              | 0 /<br>8 06 E. | Capt. J. Cook; in $\phi = 19^{\circ} 28'$ , $\lambda = 156^{\circ} 00'$ W. P. Barlow in <i>Encycl. Metropol.</i> , London, 1848.                                                                                                                                                                             |
| 2 | 1791, October 4, 8. | 8 02 E.        | Capt. Etienne Marchand; west of Hawaii. <i>Voyage autour du Monde</i> , Paris, an vii, vol. 2. On Oct. 4, declination = $8^{\circ} 00'$ E., in $\phi = 19^{\circ} 13'$ , $\lambda = 154^{\circ} 34'$ W.; on Oct. 8, decl'n = $8^{\circ} 05'$ E., in $\phi = 19^{\circ} 19'$ , $\lambda = 157^{\circ} 22'$ W. |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

KAILUA (KAIRUA), HILO AND KEALAKEKUA (KARAKAKOA) BAYS, ISLAND OF HAWAII (OWHYHEE), SANDWICH ISLANDS—Continued.

|    |                  |       |    |                                                                                                                                                                                                                           |
|----|------------------|-------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3  | 1795, March.     | 7 47  | E  | Capt. G. Vancouver; A Voyage of Discovery, etc., London, 1804. Mean of 3 compasses on ship and on shore, in $\phi = 19^{\circ} 28'.2$ , $\lambda = 156^{\circ} 02'.2$ W. See also Encycl. Metropol., London, 1848.        |
| 4  | 1796--           | 8 15  | }  | Lieut. W. R. Broughton; Encycl. Metropol., London, 1848. [Second value not used—SCH.]                                                                                                                                     |
|    | 1796--           | 9 12  |    |                                                                                                                                                                                                                           |
| 5  | 1818, October.   | 7 30  |    | Capt. V. M. Golovnin, at Kairua Bay. Voyage around the world, St. Petersburg, 1822, vol. 2.                                                                                                                               |
| 6  | 1819--           | 9 50  |    | Capt. Freycinet; at Kawaihae, in $\phi = 20^{\circ}.5$ , northwest Hawaii.                                                                                                                                                |
|    | 1824--           | 10 14 |    | Byron; Island of Owhyhee in $\phi = 19^{\circ} 43'$ , $\lambda = 156^{\circ} 10'$ W. Gen. Sir Edw. Sabine's Cont's to Terr. Mag., No. xiv; in Phil. Trans. Roy. Soc., vol. 165, pt. i, 1875. [Not used—SCH.]              |
| 7  | 1825--           | 8 51  |    | Byron; at Hilo. Communicated by W. D. Alexander, supt. Hawaiian Government Survey, letter of Dec. 11, 1877.                                                                                                               |
|    | 1835--           | 7 43  |    | Voyage de la Vénus, Paris, 1841. Position and reference as for the value for 1824, above. [Not used.—SCH.]                                                                                                                |
| 8  | 1841--           | 8 50  |    | Commander C. Wilkes, U. S. N.; at Hilo. Communicated by Mr. W. D. Alexander, Supt. Hawaiian Survey.                                                                                                                       |
| 9  | 1845, March 8.   | 9 27  |    | U. S. Hydrographic Office. U. S. S. Brandywine at sea, in $\phi = 19^{\circ} 35'$ , $\lambda = 158^{\circ} 14'$ W. [Reduction to Kailua $+6'$ , hence declination— $9^{\circ} 21'$ —SCH.]                                 |
| 10 | 1853--           | 8 15  |    | C. J. Lyons, asst. Hawaiian Government Survey; on shore at Kawaihae. Comm'd by Mr. W. D. Alexander, supt. Haw. Survey.                                                                                                    |
| 11 | 1875, August 18. | 7 34  |    | H. M. S. Challenger; Hilo, on Cocoanut Island, in $\phi = 19^{\circ} 43'.9$ , $\lambda = 155^{\circ} 04'.0$ W. Rock consists of lava, and very magnetic. Voyage of H. M. S. Challenger, Narrative, vol. ii, London, 1882. |
| 12 | 1877--           | 8 10  |    | Observer, C. J. Lyons; in Hamakua and North Hilo, N. E. coast of Hawaii. Comm'd as for No. 10. [10' may be subtracted to refer to latitudes of Hilo and Kailua, hence decl'n— $8^{\circ}.0$ —SCH.]                        |
| 13 | 1884.0           | 8 30  | E. | Letter of C. J. Lyons, dated Honolulu, Jan. 9, 1884; considered by him as the best value for this date, as based upon actual survey.                                                                                      |

## 29.—HONOLULU, ISLAND OF OAHU (WOAHOO), SANDWICH ISLANDS.

$$\phi = +21^{\circ} 18'.2 \quad \lambda = 157^{\circ} 55'.0 \text{ W. of Gr.}$$

(Fort near town.)

|   |                 |      |    |                                                                                                                                                                                                                                                |
|---|-----------------|------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | 1792, March.    | 7 50 | E. | Capt. G. Vancouver; observed on board ship, at anchor in Whyteete Bay, in $\phi = 21^{\circ} 16'.8$ , $\lambda = 157^{\circ} 50'.4$ W. Voyage around the world, London, 1798, vol. i. Communicated by Mr. M. Baker, Coast and Geodetic Survey. |
|   | 1793--          | 5 52 |    | Capt. G. Vancouver; at Waikiki, south of Honolulu. Communicated by Mr. W. D. Alexander, supt. Hawaiian Government Survey, in letter dated Mikawao, Maui, Dec. 11, 1877. [Not used—SCH.]                                                        |
| 2 | 1796, February. | 9 41 | E. | Lieut. W. R. Broughton; Whyteete Bay, in $\phi = 21^{\circ} 18'$ , $\lambda = 157^{\circ} 59'.5$ W. A Voyage of Discovery, London, 1804. Communicated by Mr. M. Baker.                                                                         |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

HONOLULU, ISLAND OF OAHU (WOAHOO), SANDWICH ISLANDS—Continued.

|    |                                     |        |    |                                                                                                                                                                                                               |
|----|-------------------------------------|--------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | 1816..                              | 10 57  | E. | Kotzebue; at Honolulu. Communicated by Mr. W. D. Alexander, supt. H. S. [Not used—SCH.]                                                                                                                       |
| 3  | 1819..                              | 10 24  |    | Capt. Freycinet; at Honolulu. Reference as above.                                                                                                                                                             |
| 4  | 1824-'25.                           | 9 52   |    | Byron; from L. S. Kaemtz's MSS. Oahu Island, in $\phi = 21^{\circ} 17'$ , $\lambda = 158^{\circ} 00'$ W. Gen. Sir Edw. Sabine's Cont's to Terr. Mag., No. xiv. Phil. Trans. Roy. Soc., vol. 165, pt. i, 1875. |
| 5  | 1827..                              | 10 26  |    | Capt. Beechey; position and reference as above.                                                                                                                                                               |
| 6  | 1836..                              | 10 11  |    | Voyage de la Bonite, Paris, 1842. Honolulu, in $\phi = 21^{\circ} 19'$ , $\lambda = 157^{\circ} 48'$ W. Reference to Phil. Trans. as above.                                                                   |
| 7  | 1837..                              | 10 00  |    | Voyage de la Vénus, Paris, 1841. Position and reference as above.                                                                                                                                             |
|    | 1837..                              | 10 39  |    | Capt. Beechey. On Oahu Island. Reference as above. [Mean value for                                                                                                                                            |
| 8  | 1838..                              | 10 39  |    | Capt. Belcher. 1837.5, = $-10^{\circ}.32$ —SCH.]                                                                                                                                                              |
| 9  | 1840..                              | 9 17   |    | Berghaus; from L. S. Kaemtz' MSS.; at Honolulu.                                                                                                                                                               |
|    | 1841..                              | 8 15   |    | Commander C. Wilkes, U. S. N.; at Honolulu. Communicated by Mr. W. D. Alexander, supt. H. S. Not used—SCH.]                                                                                                   |
| 10 | 1845, January 25.                   | 10 10  |    | U. S. Hydrographic Office; U. S. S. Brandywine, at sea, in $\phi = 21^{\circ} 54'$ , $\lambda = 157^{\circ} 05'$ W. [Reduction to Honolulu + 5', hence declination = $-10^{\circ} 05'$ —SCH.]                 |
| 11 | 1852..                              | 9 10   |    | Capt. Collinson, MS. in Brit. Hydr. Office. At Honolulu. Gen. Sir. Edw. Sabine, in Phil. Trans. Roy. Soc., vol. 165, p. i, 1875.                                                                              |
| 12 | 1859, January, February, and March. | 9 42   |    | Karl Friesach; Memoirs of the Imperial Academy of Sciences, Vienna, vols. xxix to xliv. In $-21^{\circ} 18'.6$ , $= 157^{\circ} 48'.9$ W.                                                                     |
|    | 1867, August.                       | 11 15  |    | Capt. W. Reynolds, U. S. N., in the Lackawanna; Chart No. 6. Wharf near custom house, in $\phi = 21^{\circ} 18'.2$ , $= 157^{\circ} 50'.1$ W. [Not used—SCH.]                                                 |
| 13 | 1871..                              | 9 36   |    | C. J. Lyons, asst. Government Survey; north side of entrance to Honolulu harbor. Comm'd by W. D. Alexander, supt. H. G. S., letter of Dec. 11, 1877.                                                          |
| 14 | 1872..                              | 9 18   |    | Observer and reference as above. On the south side of entrance, at Fisherman's Point.                                                                                                                         |
| 15 | 1873..                              | 9 25   |    | Observer as before, in Punchbowl street, in $\phi = 21^{\circ} 18'$ , $\lambda = 157^{\circ} 52'$ W. Comm'd by C. J. Lyons, letters of Jan. 9 and Apr. 23, 1884.                                              |
|    | 1873..                              | 9 50   |    | Observer and reference as before. West base Oahu triangulation, Honolulu. [Mean value for 1873.5, = $-9^{\circ}.63$ —SCH.]                                                                                    |
|    | 1875..                              | 9 16   |    | W. D. Alexander; entrance of Pearl Locks, Oahu, and throughout Ewa district. Reference as for 1871.                                                                                                           |
| 16 | 1875, July 29, 30, August 10.       | 9 40.4 |    | H. M. S. Challenger; on spit south of town in $\phi = 21^{\circ} 18'.0$ , $\lambda = 157^{\circ} 51'$ W. Voyage of H. M. S. Challenger, Narrative, vol. ii, London, 1882.                                     |
|    | 1875..                              | 9 15   |    | Observer and reference as for first value of 1875. Shore of Waikiki, south of Honolulu. [Mean value = $-9^{\circ}.40$ —SCH.]                                                                                  |
| 17 | 1879..                              | 9 32   |    | Observer, position, and reference as for 1873.                                                                                                                                                                |
| 18 | 1881..                              | 9 40   | E. | Observer, position, and reference as for 1873.                                                                                                                                                                |

GROUP III.—*Series of Magnetic Stations mainly on the Pacific Coast, etc.*—Continued.

HONOLULU, ISLAND OF OAHU (WOAHOO), SANDWICH ISLANDS—Continued.

|    |                  |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----|------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19 | 1883, June 17.   | 10 42 E. | Lieut. W. H. Parker in the U. S. S. Essex; at sea, in $\phi = 21^{\circ} 15'$ , $\lambda = 156^{\circ} 13'$ W. Naval Professional Papers, No. 19, Washington, 1886. [Reduction to Honolulu inappreciable.—SCH.]                                                                                                                                                                                                                                                               |
|    | 1883, August 19. | 9 09     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 20 | 1884. o.         | 10 14    | Observer and reference as for 1873, at west base, Honolulu.<br>C. J. Lyons, asst. H. G. S.; at old station of 1841 occupied by Commander C. Wilkes. Letters of Jan. 9 and Apr. 23, 1884.<br>Lieut. W. Swift in U. S. S. Alert; at sea, in $\phi = 20^{\circ} 35'$ , $\lambda = 157^{\circ} 45'$ W. Naval Professional Papers, No. 19, Washington, 1886. [Reduction to Honolulu $-10'$ , hence decl'n $= -9^{\circ} 07'$ . Mean of 3 determinations $= -9^{\circ} 57'$ .—SCH.] |
|    | 1884. o.         | 9 30     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|    | 1884, January 4. | 9 57 E.  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

The values available for discussion of the declination at the Sandwich Islands after rejecting 3 apparently anomalous ones for Kailua and 4 such in the Honolulu series are as follows:

## KAILUA BAY, HAWAII.

| No. | Year.  | Decl'n. | No. | Year.    | Decl'n.   | No. | Year.    | Decl'n. | No. | Year.  | Decl'n. |
|-----|--------|---------|-----|----------|-----------|-----|----------|---------|-----|--------|---------|
| 1   | 1779.5 | $-8.10$ |     | (1796.0) | $(-9.20)$ | 7   | 1825.5   | $-8.85$ | 10  | 1853.5 | $-8.25$ |
| 2   | 1791.7 | 8.03    | 5   | 1818.8   | 7.50      |     | (1836.5) | (7.62)  | 11  | 1875.6 | 7.57    |
| 3   | 1793.2 | 7.78    | 6   | 1819.5   | 9.83      | 8   | 1841.5   | 8.83    | 12  | 1877.5 | 8.00    |
| 4   | 1796.0 | 8.25    |     | (1824.5) | (10.23)   | 9   | 1845.2   | 9.35    | 13  | 1884.0 | 8.50    |

## HONOLULU, OAHU.

| No. | Year.    | Decl'n. | No. | Year.    | Decl'n.  | No. | Year.    | Decl'n.  | No. | Year.  | Decl'n. |
|-----|----------|---------|-----|----------|----------|-----|----------|----------|-----|--------|---------|
| 1   | 1792.2   | $-7.83$ | 5   | 1827.5   | $-10.43$ | 10  | 1845.1   | $-10.08$ | 15  | 1873.5 | $-9.63$ |
|     | (1793.5) | (5.87)  | 6   | 1836.5   | 10.18    | 11  | 1852.5   | 9.17     | 16  | 1875.5 | 9.40    |
| 2   | 1796.1   | 9.68    | 7   | 1837.5   | 10.32    | 12  | 1859.2   | 9.70     | 17  | 1879.5 | 9.54    |
|     | (1816.5) | (10.95) | 8   | 1838.5   | 10.65    |     | (1867.6) | (11.25)  | 18  | 1881.5 | 9.67    |
| 3   | 1819.5   | 10.40   | 9   | 1840.5   | 9.28     | 13  | 1871.5   | 9.60     | 19  | 1883.5 | 9.95    |
| 4   | 1825.0   | 9.87    |     | (1841.5) | (8.25)   | 14  | 1872.5   | 9.30     | 20  | 1884.0 | 9.95    |

Observations inclosed within parentheses are proposed for omission in any process for representation that may be employed.

No expression of the above observations by means of a periodic function will for the present be attempted, as it seems impossible, without undue and arbitrary straining, to reconcile such a formula with the condition imposed upon by Mr. Lyons, *i. e.*, that the easterly declination was *increasing* on the islands from about the middle of the century to the present time; we therefore prefer to suspend our judgment as to the direction and amount of the secular change at the present time, and shall wait for further development.

In a volcanic region like that of the Sandwich Islands it is absolutely essential for the elucidation of the secular change in any of the magnetic elements that the successive observations should be made at the same stations, otherwise local disturbances may completely hide the true progressive movement and render all comparison nugatory. Even with this precaution we are obliged to assume that the law of secular change has not at times been suddenly interrupted through the agency of volcanic eruptions or through the effects of earthquakes.

A complete magnetic survey of this group of islands could not fail to throw much light on the distribution and character of the local disturbances as well as furnish evidence whether or not the secular change over disturbed and undisturbed regions is the same, and it is to be hoped that it will be undertaken by the Hawaiian Government Survey.

The Sandwich Islands group is magnetically considered no less interesting than are the Bermuda Islands, in which latter group, however, there is less liability to abrupt local changes in the curves representing the distribution of magnetism than in the former.

RESULTS FOR GROUP III.—Magnetic stations on the western coast and the Rocky Mountain region, inclusive of Mexico and Alaska and some foreign localities.

Geographical positions and expressions for the secular variation of the magnetic declination  $D$  (+ West, — East). The letter  $m$  stands for  $t-1850.0$  or for the difference in time, expressed in years and fraction of a year, for any time  $t$  and the middle of the century, within the range of observation at any station. A minus sign of  $D$  indicates east declination.

| No. | Name of station and State.       | Latitude. | West longitude. | The magnetic declination expressed as a function of time. |
|-----|----------------------------------|-----------|-----------------|-----------------------------------------------------------|
| 1   | Acapulco, Mexico.                | 16 50.5   | 99 52.3         | $D = -4.48 + 4.41 \sin(1.0 m - 85.7)^*$                   |
| 2   | Vera Cruz, Mexico.               | 19 11.9   | 96 08.8         | $D = -5.09 + 4.22 \sin(1.2 m - 63.4)^*$                   |
| 3   | City of Mexico, Mexico.          | 19 26.0   | 99 11.6         | $D = -5.34 + 3.28 \sin(1.0 m - 87.9)^*$                   |
| 4   | San Blas, Mexico.                | 21 32.5   | 105 18.4        | $D = -6.22 + 3.20 \sin(1.25 m - 103.2)$                   |
| 5   | El Paso, Tex.                    | 31 46     | 106 30          | $D = -9.10 + 3.40 \sin(1.3 m - 108.4)^*$                  |
| 6   | Magdalena Bay, Lower California. | 24 38.4   | 112 08.9        | $D = -8.87 + 2.20 \sin(1.25 m - 163.7)^*$                 |
| 7   | San Diego, Cal.                  | 32 42.1   | 117 14.3        | $D = -11.78 + 1.90 \sin(1.15 m - 151.6)$                  |
| 8   | Santa Barbara, Cal.              | 34 24.2   | 119 43.0        | $D = -12.97 + 2.08 \sin(1.3 m - 146.3)$                   |
| 9   | Monterey, Cal.                   | 36 36.1   | 121 53.6        | $D = -13.79 + 2.65 \sin(1.10 m - 156.4)$                  |
| 10  | San Francisco, Cal.              | 37 47.5   | 122 27.3        | $D = -13.94 + 2.65 \sin(1.05 m - 135.5)$                  |
| 11  | Salt Lake City, Utah.            | 40 46.1   | 111 53.8        | $D = -12.40 + 4.25 \sin(1.4 m - 121.6)^*$                 |
| 12  | Cape Mendocino, Cal.             | 40 26.3   | 124 24.3        | $D = -15.25 + 2.45 \sin(1.10 m - 128.0)^*$                |
| 13  | Vancouver, Wash. T.              | 45 37.5   | 122 39.7        | $D = -17.93 + 3.12 \sin(1.35 m - 134.1)^*$                |
| 14  | Wallula, Wash. T.                | 46 05     | 118 55          | $D = -17.00 + 3.08 \sin(1.3 m - 118.1)^*$                 |
| 15  | Cape Disappointment, Wash        | 46 16.7   | 124 02.8        | $D = -19.39 + 2.54 \sin(1.25 m - 158.7)$                  |
| 16  | Seattle, Wash. T.                | 47 35.9   | 122 20.0        | $D = -19.15 + 3.14 \sin(1.4 m - 136.5)^*$                 |
| 17  | Port Townsend, Wash. T.          | 48 07.0   | 122 44.9        | $D = -18.84 + 3.00 \sin(1.45 m - 122.1)$                  |
| 18  | Nee-ah Bay, Wash. T.             | 48 21.8   | 124 38.0        | $D = -19.83 + 2.91 \sin(1.40 m - 141.6)$                  |
| 19  | Nootka, Vancouver Island.        | 49 35.5   | 126 37.5        | $D = -21.25 + 2.74 \sin(1.30 m - 152.0)^*$                |
| 20  | Sitka, Alaska.                   | 57 02.9   | 135 19.7        | $D = -25.79 + 3.30 \sin(1.30 m - 104.2)$                  |
| 21  | Port Mulgrave, Alaska.           | 59 33.7   | 139 45.9        | $D = -24.03 + 7.77 \sin(1.30 m - 85.8)$                   |
| 22  | Port Etches, Alaska.             | 60 20.7   | 146 37.6        | $D = -23.71 + 7.89 \sin(1.35 m - 80.9)$                   |
| 23  | St. Paul, Kadiak Island.         | 57 48.0   | 152 21.3        | $D = -22.21 + 5.18 \sin(1.35 m - 72.5)$                   |
| 24  | Captain's and Iliuliuk Harbors   | 53 52.6   | 166 31.5        | $D = -18.01 + 1.82 \sin(1.3 m - 69.6)^*$                  |
| 25  | Port Clarence, Alaska.           | 65 16     | 166 50          | $D = -18.98 + 7.99 \sin(1.3 m - 68.4)^*$                  |
| 26  | Chamisso Island, Alaska.         | 66 13     | 161 49          | $D = -23.62 + 7.64 \sin(1.3 m - 64.0)^*$                  |
| 27  | Petropavlovsk, Siberia.          | 53 01     | 201 17          | $D = -3.35 + 2.97 \sin(1.3 m + 12.2)$                     |

\* Approximate expression.

## GROUP III.—Comparison of observed and computed Magnetic Declinations.

| Year and fraction.   | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.        | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.  | Obs'd decl'n. | Comp'd decl'n. | O—C.  |
|----------------------|---------------|----------------|-------|---------------------------|---------------|----------------|-------|---------------------|---------------|----------------|-------|
| ACAPULCO, MEX.       |               |                |       | SAN BLAS, MEX.—continued. |               |                |       | MONTEREY, CAL.      |               |                |       |
| 1744.5               | — 3.00        | — 3.62         | + .62 | 1837.5                    | — 8.85        | — 9.02         | + .17 | 1783.3              | —12.44        | —11.77         | — .67 |
| 1791.3               | 7.73          | 7.05           | — .68 | 1838.5                    | 8.79          | 9.06           | + .27 | 1786.7              | 11.80         | 11.89          | + .09 |
| 1822.5               | 8.67          | 8.53           | — .14 | 1839.5                    | 9.00          | 9.09           | + .09 | 1791.7              | 10.93         | 12.07          | +1.14 |
| 1828.5               | 9.12          | 8.69           | — .43 | 1841.5                    | 9.20          | 9.15           | — .05 | 1792.9              | 12.37         | 12.12          | — .25 |
| 1838.0               | 8.29          | 8.85           | + .56 | 1874.1                    | 9.14          | 9.28           | + .14 | 1794.9              | 12.37         | 12.19          | — .18 |
| 1866.5               | 8.37          | 8.60           | + .23 | 1880.9                    | — 9.30        | — 9.11         | — .19 | 1837.5              | 14.50         | 14.24          | — .26 |
| 1874.2               | 8.64          | 8.36           | — .28 | EL PASO, TEX.             |               |                |       | 1839.5              | 14.22         | 14.34          | + .12 |
| 1880.9               | 7.94          | 8.08           | + .14 | 1852.5                    | —12.40        | —12.38         | — .02 | 1841.5              | 15.00         | 14.44          | — .56 |
| 1882.9               | — 7.90        | — 7.99         | + .09 | 1859.1                    | 12.42         | 12.48          | + .06 | 1843.5              | 14.00         | 14.54          | + .54 |
| VERA CRUZ, MEX.      |               |                |       | 1878.5                    | 12.42         | 12.32          | — .10 | 1851.1              | 14.97         | 14.90          | — .07 |
| 1727.0               | — 2.25        | — 2.92         | + .67 | 1884.3                    | —12.08        | —12.15         | + .07 | 1854.4              | 14.98         | 15.05          | + .07 |
| 1769.4               | 6.57          | 6.53           | — .04 | MAGDALENA BAY, LOWER CAL. |               |                |       | 1873.7              | 15.92         | 15.81          | — .11 |
| 1776.5               | 7.50          | 7.10           | — .40 | 1783.3                    | — 6.78        | — 6.84         | + .06 | 1881.3              | —15.90        | —16.04         | + .14 |
| 1815.5               | 10.62         | 9.17           | —1.45 | 1837.5                    | 8.27          | 8.90           | + .63 | SAN FRANCISCO, CAL. |               |                |       |
| 1819.3               | 9.27          | 9.24           | — .03 | 1839.5                    | 9.25          | 8.99           | — .26 | 1783.3              | —12.91        | —12.80         | — .11 |
| 1839.5               | 8.37          | 9.18           | + .81 | 1866.4                    | 10.67         | 10.19          | — .48 | 1792.9              | 12.80         | 13.23          | + .43 |
| 1856.6               | 8.28          | 8.57           | + .29 | 1871.3                    | 11.00         | 10.37          | — .63 | 1818.7              | 15.00         | 14.47          | — .53 |
| 1861.0               | 8.33          | 8.33           | .00   | 1873.3                    | 10.56         | 10.44          | — .12 | 1827.5              | 15.45         | 14.89          | — .56 |
| 1880.1               | — 7.44        | — 7.02         | — .42 | 1881.1                    | —10.48        | —10.68         | + .20 | 1829.9              | 14.92         | 14.99          | + .07 |
| CITY OF MEXICO, MEX. |               |                |       | SAN DIEGO, CAL.           |               |                |       | 1830.5              | 14.85         | 15.02          | + .17 |
| 1769.7               | — 5.46        | — 6.01         | + .55 | 1783.3                    | —10.44        | —10.36         | — .08 | 1837.5              | 15.17         | 15.31          | + .14 |
| 1775.5               | 6.70          | 6.33           | — .37 | 1792.5                    | 11.00         | 10.62          | — .38 | 1839.5              | 15.33         | 15.40          | + .07 |
| 1804.0               | 8.13          | 7.70           | — .43 | 1839.5                    | 12.34         | 12.21          | — .13 | 1841.9              | 15.50         | 15.50          | .00   |
| 1849.5               | 8.50          | 8.62           | + .12 | 1851.3                    | 12.48         | 12.73          | + .25 | 1850.0              | 15.68         | 15.80          | + .12 |
| 1850.5               | 8.59          | 8.62           | + .03 | 1853.8                    | 12.53         | 12.81          | + .28 | 1852.3              | 15.48         | 15.87          | + .39 |
| 1856.9               | 8.77          | 8.58           | — .19 | 1866.4                    | 13.16         | 13.18          | + .02 | 1858.4              | 15.88         | 16.06          | + .18 |
| 1858.5               | 8.37          | 8.56           | + .19 | 1872.9                    | 13.32         | 13.33          | + .01 | 1866.5              | 16.42         | 16.27          | — .15 |
| 1860.5               | 8.50          | 8.54           | + .04 | 1881.3                    | —13.46        | —13.49         | + .03 | 1871.9              | 16.38         | 16.39          | + .01 |
| 1862.5               | 8.46          | 8.52           | + .06 | SANTA BARBARA, CAL.       |               |                |       | 1872.8              | 16.43         | 16.40          | — .03 |
| 1867.0               | 8.15          | 8.44           | + .29 | 1783.3                    | —11.36        | —11.31         | — .05 | 1873.7              | 16.41         | 16.42          | + .01 |
| 1868.5               | 8.17          | 8.41           | + .24 | 1839.5                    | 13.47         | 13.68          | + .21 | 1874.0              | 16.45         | 16.43          | — .02 |
| 1879.8               | 8.58          | 8.12           | — .46 | 1869.9                    | 15.20         | 14.76          | — .44 | 1879.2              | 16.57         | 16.50          | — .07 |
| 1884.3               | — 8.32        | — 7.98         | — .34 | 1881.3                    | —14.87        | —14.97         | + .10 | 1880.8              | 16.56         | 16.52          | — .04 |
| SAN BLAS, MEX.       |               |                |       | SALT LAKE CITY, UTAH.     |               |                |       | 1881.5              | 16.48         | 16.53          | + .05 |
| 1788.2               | — 5.00        | — 6.20         | +1.20 | 1850.5                    | —15.57        | —16.05         | + .48 | 1883.4              | 16.64         | 16.54          | — .10 |
| 1791.3               | 7.47          | 6.41           | —1.06 | 1866.6                    | —16.50        | —16.60         | + .10 | 1884.7              | 16.54         | 16.56          | + .02 |
| 1822.0               | — 8.67        | — 8.35         | — .32 |                           |               |                |       | 1885.6              | 16.56         | 16.56          | .00   |
|                      |               |                |       |                           |               |                |       | 1886.3              | —16.55        | —16.57         | + .02 |

## GROUP III.—Comparison of observed and computed Magnetic Declinations—Continued.

| Year and fraction.              | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.                  | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.                  | Obs'd decl'n. | Comp'd decl'n. | O—C.  |
|---------------------------------|---------------|----------------|-------|-------------------------------------|---------------|----------------|-------|-------------------------------------|---------------|----------------|-------|
| SALT LAKE CITY, UTAH—continued. |               |                |       | SEATTLE, DUWAMISH BAY, WASH. T.     |               |                |       | SITKA, ALASKA—continued.            |               |                |       |
| 1869.4                          | —16.61        | —16.64         | + .03 | 1783.3                              | —16.75        | —16.75         | .00   | 1827.5                              | —28.83        | —28.19         | — .64 |
| 1872.5                          | 17.02         | 16.65          | — .37 | 1855.5                              | 21.42         | 21.60          | + .18 | 1829.9                              | 28.31         | 28.31          | .00   |
| 1878.7                          | 16.77         | 16.60          | — .17 | 1871.8                              | 22.59         | 22.17          | — .42 | 1838.6                              | 28.62         | 28.68          | + .06 |
| 1881.4                          | 16.47         | 16.55          | + .08 | 1881.8                              | —22.04        | —22.29         | + .25 | 1842.6                              | 28.54         | 28.81          | + .27 |
| 1883.9                          | 16.24         | 16.49          | + .25 | PORT TOWNSEND, WASH. T.             |               |                |       | 1843.5                              | 28.90         | 28.84          | — .06 |
| 1884.8                          | 16.23         | 16.46          | + .23 |                                     |               |                |       | 1844.5                              | 28.96         | 28.86          | — .10 |
| 1885.9                          | —16.49        | —16.42         | — .07 | 1783.3                              | —17.00        | —16.96         | — .04 | 1845.5                              | 29.00         | 28.89          | — .11 |
| CAPE MENDOCINO, CAL.            |               |                |       | 1841.5                              | 20.67         | 20.98          | + .31 | 1847.7                              | 28.98         | 28.94          | — .04 |
| 1783.3                          | —14.17        | —14.36         | + .19 | 1856.6                              | 21.66         | 21.63          | — .03 | 1848.5                              | 29.08         | 28.96          | — .12 |
| 1786.7                          | 14.90         | 14.51          | — .39 | 1857.5                              | 21.77         | 21.64          | — .13 | 1849.1                              | 29.06         | 28.97          | — .09 |
| 1792.3                          | 15.78         | 14.77          | —1.01 | 1862.5                              | 22.00         | 21.75          | — .25 | 1850.5                              | 28.84         | 29.00          | + .16 |
| 1794.7                          | 13.88         | 14.88          | +1.00 | 1876.1                              | 21.98         | 21.82          | — .16 | 1851.5                              | 28.88         | 29.01          | + .13 |
| 1854.3                          | 16.93         | 17.30          | + .37 | 1881.9                              | —21.45        | —21.75         | + .30 | 1852.4                              | 28.81         | 29.03          | + .22 |
| 1886.3                          | —18.01        | —17.70         | — .31 | NEE-AH BAY, CAPE FLATTERY, WASH. T. |               |                |       | 1856.5                              | 28.98         | 29.07          | + .09 |
| VANCOUVER, WASH. T.             |               |                |       | 1783.3                              | —17.25        | —17.45         | + .20 | 1857.5                              | 29.12         | 29.08          | — .04 |
| 1788.6                          | —14.57        | —16.05         | +1.48 | 1792.3                              | 18.00         | 17.87          | — .13 | 1858.5                              | 29.18         | 29.08          | — .10 |
| 1839.5                          | 19.37         | 19.57          | + .20 | 1841.5                              | 22.50         | 21.13          | —1.37 | 1859.5                              | 29.10         | 29.09          | — .01 |
| 1859.5                          | 21.50         | 20.60          | — .90 | 1852.6                              | 21.50         | 21.78          | + .28 | 1860.5                              | 29.13         | 29.09          | — .04 |
| 1860.5                          | 20.08         | 20.64          | + .56 | 1855.6                              | 21.80         | 21.93          | + .13 | 1861.5                              | 29.07         | 29.09          | + .02 |
| 1881.8                          | —20.89        | —21.05         | + .16 | 1881.8                              | —22.74        | —22.72         | — .02 | 1862.5                              | 29.02         | 29.09          | + .07 |
| WALLULA, WASH. T.               |               |                |       | NOOTKA S'D, VANCOUVER IS'D.         |               |                |       | 1863.5                              | 29.06         | 29.08          | + .02 |
| 1853.0                          | —19.67        | —19.81         | + .14 | 1778.2                              | —19.75        | —18.76         | — .99 | 1864.5                              | 29.07         | 29.08          | + .01 |
| 1860.5                          | 20.00         | 19.98          | — .02 | 1783.3                              | 17.91         | 18.91          | +1.00 | 1867.6                              | 28.82         | 29.05          | + .23 |
| 1861.5                          | 20.50         | 20.00          | — .50 | 1786.6                              | 19.78         | 19.02          | — .76 | 1874.3                              | 28.99         | 28.93          | — .06 |
| 1881.7                          | —19.93        | —20.00         | + .07 | 1792.8                              | 18.37         | 19.27          | + .90 | 1876.1                              | 28.34         | 28.90          | + .56 |
| CAPE DISAPPOINTMENT, WASH. T.   |               |                |       | 1860.5                              | 23.78         | 23.07          | — .71 | 1879.3                              | 28.90         | 28.81          | — .09 |
| 1783.3                          | —16.39        | —17.15         | + .76 | 1863.5                              | 23.08         | 23.21          | + .13 | 1880.4                              | 29.08         | 28.77          | — .31 |
| 1786.7                          | 18.00         | 17.24          | — .76 | 1881.7                              | —23.60        | —23.81         | + .21 | 1881.7                              | —29.19        | —28.73         | — .46 |
| 1792.3                          | 18.00         | 17.42          | — .58 | SITKA, ALASKA.                      |               |                |       | PORT MULGRAVE, YAKUTAT BAY, ALASKA. |               |                |       |
| 1839.5                          | 19.18         | 19.75          | + .57 | 1779.5                              | —23.50        | —24.89         | +1.39 | 1778.3                              | —23.80        | —24.14         | + .34 |
| 1842.5                          | 20.00         | 19.91          | — .09 | 1786.5                              | 26.77         | 25.40          | —1.37 | 1787.4                              | 26.00         | 25.75          | — .25 |
| 1851.5                          | 20.32         | 20.39          | + .07 | 1787.4                              | 24.00         | 25.47          | +1.47 | 1791.5                              | 26.67         | 26.46          | — .21 |
| 1858.5                          | 21.00         | 20.73          | — .27 | 1791.6                              | 27.77         | 25.79          | —1.98 | 1794.5                              | 26.00         | 26.94          | + .94 |
| 1873.8                          | 21.44         | 21.37          | — .07 | 1804.6                              | 26.75         | 26.74          | — .01 | 1802.0                              | 29.00         | 28.13          | — .87 |
| 1881.8                          | —21.60        | —21.61         | + .01 | 1818.5                              | 27.25         | 27.67          | + .42 | 1823.5                              | 30.50         | 30.74          | + .24 |
|                                 |               |                |       | 1824.5                              | —27.50        | —28.02         | + .52 | 1874.4                              | 29.97         | 30.32          | + .35 |
|                                 |               |                |       |                                     |               |                |       | 1880.5                              | —30.00        | —29.64         | — .36 |
|                                 |               |                |       |                                     |               |                |       | PORT ETCHES, ALASKA.                |               |                |       |
|                                 |               |                |       |                                     |               |                |       | 1778.4                              | —23.62        | —24.04         | + .42 |
|                                 |               |                |       |                                     |               |                |       | 1787.4                              | —26.25        | —25.69         | — .56 |

## GROUP III.—Comparison of observed and computed Magnetic Declinations—Continued.

| Year and fraction.             | Obs'd decl'n. | Comp'd decl'n. | O—C.   | Year and fraction.                         | Obs'd decl'n. | Comp'd decl'n. | O—C.  | Year and fraction.         | Obs'd decl'n. | Comp'd decl'n. | O—C.   |
|--------------------------------|---------------|----------------|--------|--------------------------------------------|---------------|----------------|-------|----------------------------|---------------|----------------|--------|
| PORT ETCHES, ALASKA—continued. |               |                |        | ST. PAUL, KADIAK IS'D, ALASKA—cont'd.      |               |                |       | PORT CLARENCE—continued.   |               |                |        |
| 1788.4                         | —25.00        | —25.87         | + .87  | 1874.4                                     | —25.37        | —25.51         | + .14 | 1854.5                     | —26.00        | —26.08         | + .08  |
| 1790.5                         | 26.23         | 26.25          | + .02  | 1880.5                                     | —25.15        | —24.90         | — .25 | 1879.5                     | 23.02         | 22.98          | — .04  |
| 1794.5                         | 28.50         | 26.94          | — 1.56 | CAPTAIN'S AND ILIULIUK HARBORS, UNALASHKA. |               |                |       | 1880.7                     | —22.75        | —22.79         | + .04  |
| 1810.5                         | 28.13         | 29.36          | + 1.23 |                                            |               |                |       | CHAMISSO IS'D, ALASKA.     |               |                |        |
| 1830.5                         | 31.63         | 31.24          | — .39  | 1790.4                                     | —19.58        | —19.00         | — .58 | 1826.5                     | —31.29        | —31.24         | — .05  |
| 1837.7                         | 31.63         | 31.53          | — .10  | 1792.5                                     | 19.00         | 19.07          | + .07 | 1849.5                     | 30.43         | 30.52          | + .09  |
| 1874.4                         | —29.16        | —29.57         | + .41  | 1817.5                                     | 19.40         | 19.70          | + .30 | 1880.7                     | —26.82        | —26.74         | — .08  |
| ST. PAUL, KADIAK IS'D, ALASKA. |               |                |        | 1827.6                                     | 19.83         | 19.81          | — .02 | PETROPAVLOVSK, KAMTCHATKA. |               |                |        |
| 1778.4                         | —22.10        | —23.18         | + 1.08 | 1831.5                                     | 19.50         | 19.83          | + .33 | 1779.5                     | — 6.31        | — 6.27         | — .04  |
| 1790.5                         | 25.50         | 24.58          | — .92  | 1849.5                                     | 20.00         | 19.72          | — .28 | 1792.5                     | 6.00          | 5.98           | — .02  |
| 1804.6                         | 26.12         | 25.95          | — .17  | 1867.7                                     | 19.79         | 19.33          | — .46 | 1804.7                     | 5.49          | 5.51           | + .02  |
| 1808.5                         | 25.75         | 26.27          | + .52  | 1870.5                                     | 19.75         | 19.25          | — .50 | 1827.6                     | 4.07          | 4.21           | + .14  |
| 1818.5                         | 26.50         | 26.90          | + .40  | 1873.5                                     | 19.06         | 19.15          | + .09 | 1837.7                     | 3.45          | 3.54           | + .09  |
| 1834.5                         | 28.63         | 27.38          | — 1.25 | 1874.7                                     | 18.71         | 19.12          | + .41 | 1849.5                     | 2.62          | 2.75           | + .13  |
| 1839.5                         | 26.72         | 27.38          | + .66  | 1880.6                                     | 18.63         | 18.91          | + .28 | 1854.5                     | 3.67          | 2.43           | — 1.24 |
| 1845.5                         | 27.00         | 27.29          | + .29  | 1883.7                                     | —18.71        | —18.80         | + .09 | 1866.5                     | 1.42          | 1.70           | + .28  |
| 1867.7                         | —26.08        | —26.09         | + .01  | PORT CLARENCE, ALASKA. *                   |               |                |       | 1876.6                     | — 1.15        | — 1.18         | + .03  |
|                                |               |                |        | 1827.5                                     | —26.91        | —26.90         | — .01 |                            |               |                |        |
|                                |               |                |        | 1850.5                                     | —26.43        | —26.38         | — .05 |                            |               |                |        |

## RESULTS FOR GROUP III—Continued.

Contents of columns: Year of first observation, and whole number of observations used in the discussion, probable error of an observation; resulting epoch of nearest *extreme easterly* declination, with amount of maximum deflection at that epoch. A minus sign indicates east declination; annual change about the present time, for four epochs, at intervals of five years; a plus sign indicates diminishing easterly declination, a minus sign the reverse change.

| Number. | Station.                        | Year of first observation. | Number of observations. | Probable error of an observation. | Epoch of eastern elongation. | Maximum declination at epoch. | Annual change in— |        |        |        |
|---------|---------------------------------|----------------------------|-------------------------|-----------------------------------|------------------------------|-------------------------------|-------------------|--------|--------|--------|
|         |                                 |                            |                         |                                   |                              |                               | 1880.0            | 1885.0 | 1890.0 | 1895.0 |
| 1       | Acapulco.                       | 1744                       | 9                       | ±20                               | 1846                         | — 8.9                         | +2.6              | + 2.9  | + 3.2  | + 3.5  |
| 2       | Vera Cruz.                      | 1727                       | 9                       | 28                                | 1828                         | — 9.3                         | +4.7              | + 4.9  | + 5.1  | + 5.2  |
| 3       | City of Mexico.                 | 1769                       | 13                      | 13                                | 1848                         | — 8.6                         | +1.8              | + 2.1  | + 2.3  | + 2.5  |
| 4       | San Blas.                       | 1788                       | 9                       | 28                                | 1861                         | — 9.4                         | +1.7              | + 2.1  | + 2.5  | + 2.9  |
| 5       | El Paso.                        | 1852                       | 4                       | 10                                | 1864                         | —12.5                         | +1.6              | + 2.1  | + 2.6  | + 3.0  |
| 6       | Magdalena Bay.                  | 1783                       | 7                       | 22                                | 1909                         | —11.1                         | —1.7              | — 1.4  | — 1.2  | — 0.9  |
| 7       | San Diego.                      | 1783                       | 8                       | 10                                | 1904                         | —13.7                         | —1.0              | — 0.8  | — 0.6  | — 0.4  |
| 8       | Santa Barbara.                  | 1783                       | 4                       | 15                                | 1893                         | —15.0                         | —0.8              | — 0.5  | — 0.2  | — 0.1  |
| 9       | Monterey.                       | 1783                       | 13                      | 20                                | 1910                         | —16.4                         | —1.7              | — 1.4  | — 1.1  | — 0.9  |
| 10      | San Francisco.                  | 1783                       | 24                      | 10                                | 1893                         | —16.6                         | —0.7              | — 0.4  | — 0.2  | + 0.1  |
| 11      | Salt Lake City.                 | 1850                       | 9                       | 12                                | 1873                         | —16.7                         | +1.1              | + 1.8  | + 2.5  | + 3.2  |
| 12      | Cape Mendocino.                 | 1783                       | 6                       | 37                                | 1886                         | —17.7                         | —0.2              | 0.0    | + 0.3  | + 0.6  |
| 13      | Vancouver.                      | 1788                       | 5                       | 36                                | 1883                         | —21.0                         | —0.3              | + 0.2  | + 0.8  | + 1.3  |
| 14      | Wallula.                        | 1853                       | 4                       | 21                                | 1872                         | —20.1                         | +0.8              | + 1.2  | + 1.7  | + 2.1  |
| 15      | Cape Disappointment.            | 1783                       | 9                       | 23                                | 1905                         | —21.9                         | —1.7              | — 1.4  | — 1.1  | — 0.7  |
| 16      | Seattle.                        | 1855                       | 3                       | 21                                | 1883                         | —22.3                         | —0.4              | + 0.2  | + 0.8  | + 1.3  |
| 17      | Port Townsend.                  | 1841                       | 6                       | 11                                | 1872                         | —21.8                         | +0.9              | + 1.5  | + 2.0  | + 2.5  |
| 18      | Nee-ah Bay.                     | 1783                       | 6                       | 19                                | 1887                         | —22.7                         | —0.7              | — 0.2  | + 0.3  | + 0.8  |
| 19      | Nootka.                         | 1778                       | 7                       | 40                                | 1898                         | —24.0                         | —1.5              | — 1.0  | — 0.6  | — 0.2  |
| 20      | Sitka.                          | 1779                       | 35                      | 21                                | 1861                         | —29.1                         | +1.9              | + 2.3  | + 2.7  | + 3.1  |
| 21      | Port Mulgrave.                  | 1778                       | 8                       | 28                                | 1847                         | —31.8                         | +7.2              | + 8.1  | + 8.8  | + 9.4  |
| 22      | Port Etches.                    | 1778                       | 9                       | 36                                | 1843                         | —31.6                         | +8.5              | + 9.3  | + 9.9  | +10.5  |
| 23      | St. Paul, Kodiak.               | 1778                       | 11                      | 31                                | 1837                         | —27.4                         | +6.2              | + 6.6  | + 6.9  | + 7.2  |
| 24      | Captain's and Iliuliuk Harbors. | 1790                       | 12                      | 14                                | 1834                         | —19.8                         | +2.1              | + 2.3  | + 2.4  | + 2.4  |
| 25      | Port Clarence.                  | 1827                       | 5                       | 15                                | 1833                         | —27.0                         | +9.5              | +10.0  | +10.4  | +10.7  |
| 26      | Chamisso Island.                | 1826                       | 3                       | 15                                | 1830                         | —31.3                         | +9.4              | + 9.9  | +10.2  | +10.4  |
| 27      | Petropavlovsk.                  | 1779                       | 9                       | 16                                | 1771                         | — 6.3                         | +2.5              | + 2.2  | + 1.8  | + 1.3  |

## RESULTS FOR GROUP III—Completed.

Ephemeris of magnetic declinations. Computed magnetic declination at each station for every tenth year of the series, and after 1850 for every fifth year. A minus sign signifies east declination, a plus sign west declination. The *first* tabular result for any station indicates that the first observation made there falls between the tabular date and the next one following it.

| Year<br>(January 1). | Acapulco, Mex-<br>ico. | Vera Cruz, Mex-<br>ico. | City of Mexico,<br>Mexico. | San Blas, Mex-<br>ico. | El Paso, Tex. | Magdalena Bay,<br>Lower California. | San Diego, Cal. | Santa<br>Barbara,<br>Cal. | Monterey, Cal. |
|----------------------|------------------------|-------------------------|----------------------------|------------------------|---------------|-------------------------------------|-----------------|---------------------------|----------------|
| 1700                 | °                      | °                       | °                          | °                      | °             | °                                   | °               | °                         | °              |
| 10                   | ----                   | ----                    | ----                       | ----                   | ----          | ----                                | ----            | ----                      | ----           |
| 20                   |                        | -2.4                    |                            |                        |               |                                     |                 |                           |                |
| 30                   |                        | 3.2                     |                            |                        |               |                                     |                 |                           |                |
| 40                   | -3.3                   | 4.0                     |                            |                        |               |                                     |                 |                           |                |
| 50                   | 4.0                    | 4.8                     | ----                       | ----                   | ----          | ----                                | ----            | ----                      | ----           |
| 60                   | 4.8                    | 5.7                     | -5.4                       |                        |               |                                     |                 |                           |                |
| 70                   | 5.6                    | 6.6                     | 6.0                        |                        |               |                                     |                 |                           |                |
| 80                   | 6.3                    | 7.4                     | 6.6                        | -5.6                   |               | -6.8                                | -10.3           | -11.2                     | -11.7          |
| 90                   | 7.0                    | 8.0                     | 7.1                        | 6.3                    |               | 7.0                                 | 10.5            | 11.5                      | 12.0           |
| 1800                 | 7.6                    | 8.6                     | 7.5                        | 7.0                    | ----          | 7.3                                 | 10.9            | 11.9                      | 12.41          |
| 10                   | 8.1                    | 9.0                     | 7.9                        | 7.7                    |               | 7.7                                 | 11.21           | 12.3                      | 12.87          |
| 20                   | 8.5                    | 9.3                     | 8.2                        | 8.24                   |               | 8.1                                 | 11.58           | 12.8                      | 13.36          |
| 30                   | 8.7                    | 9.3                     | 8.5                        | 8.73                   |               | 8.5                                 | 11.96           | 13.25                     | 13.86          |
| 40                   | 8.9                    | 9.2                     | 8.6                        | 9.10                   |               | 9.0                                 | 12.33           | 13.70                     | 14.37          |
| 50                   | 8.88                   | 8.86                    | 8.62                       | 9.33                   | -12.3         | 9.48                                | 12.68           | 14.12                     | 14.85          |
| 55                   | 8.83                   | 8.64                    | 8.59                       | 9.39                   | 12.4          | 9.71                                | 12.85           | 14.31                     | 15.08          |
| 60                   | 8.75                   | 8.39                    | 8.55                       | 9.42                   | 12.49         | 9.93                                | 13.00           | 14.48                     | 15.29          |
| 65                   | 8.64                   | 8.10                    | 8.48                       | 9.40                   | 12.50         | 10.13                               | 13.14           | 14.64                     | 15.49          |
| 70                   | 8.50                   | 7.77                    | 8.39                       | 9.35                   | 12.47         | 10.32                               | 13.27           | 14.77                     | 15.69          |
| 75                   | 8.33                   | 7.41                    | 8.26                       | 9.26                   | 12.40         | 10.49                               | 13.38           | 14.87                     | 15.85          |
| 80                   | 8.12                   | 7.03                    | 8.13                       | 9.14                   | 12.28         | 10.64                               | 13.47           | 14.96                     | 16.00          |
| 85                   | 7.89                   | 6.63                    | 7.96                       | 8.98                   | 12.13         | 10.78                               | 13.55           | 15.0                      | 16.13          |
| 90                   | 7.64                   | 6.21                    | 7.77                       | 8.78                   | 11.9          | 10.88                               | 13.6            | 15.0                      | 16.24          |
| 1895                 | -7.4                   | -5.8                    | -7.6                       | -8.6                   | -11.7         | -11.0                               | -13.6           | -15.0                     | -16.3          |

## RESULTS FOR GROUP III—Completed.

| Year<br>(January 1). | San Francisco, Cal. | Salt Lake City, Utah. | Cape Mendocino, Cal. | Vancouver, Wash. T. | Walla, Wash. T. | Cape Disappointment,<br>Wash. T. | Seattle, Duwamish<br>Bay, Wash. T. | Port Townsend,<br>Wash. T. | Neeah Bay, near<br>Cape Flattery, W. T. |
|----------------------|---------------------|-----------------------|----------------------|---------------------|-----------------|----------------------------------|------------------------------------|----------------------------|-----------------------------------------|
| 1700                 | °                   | °                     | °                    | °                   | °               | °                                | °                                  | °                          | °                                       |
| 10                   | ---                 | ---                   | ---                  | ---                 | ---             | ---                              | ---                                | ---                        | ---                                     |
| 20                   |                     |                       |                      |                     |                 |                                  |                                    |                            |                                         |
| 30                   |                     |                       |                      |                     |                 |                                  |                                    |                            |                                         |
| 40                   |                     |                       |                      |                     |                 |                                  |                                    |                            |                                         |
| 50                   | ---                 | ---                   | ---                  | ---                 | ---             | ---                              | ---                                | ---                        | ---                                     |
| 60                   |                     |                       |                      |                     |                 |                                  |                                    |                            |                                         |
| 70                   |                     |                       |                      |                     |                 |                                  |                                    |                            |                                         |
| 80                   | -12.6               |                       | -14.2                | -15.6               |                 | -17.1                            |                                    | -16.8                      | -17.3                                   |
| 90                   | 13.1                |                       | 14.7                 | 16.1                |                 | 17.3                             |                                    | 17.4                       | 17.8                                    |
| 1800                 | 13.6                | ---                   | 15.1                 | 16.8                | ---             | 17.7                             | ---                                | 18.1                       | 18.3                                    |
| 10                   | 14.1                |                       | 15.6                 | 17.5                |                 | 18.2                             |                                    | 18.8                       | 18.9                                    |
| 20                   | 14.54               |                       | 16.0                 | 18.2                |                 | 18.7                             |                                    | 19.6                       | 19.6                                    |
| 30                   | 15.00               |                       | 16.5                 | 18.9                |                 | 19.2                             |                                    | 20.3                       | 20.3                                    |
| 40                   | 15.42               |                       | 16.9                 | 19.6                |                 | 19.8                             |                                    | 20.9                       | 21.0                                    |
| 50                   | 15.79               | -16.0                 | 17.2                 | 20.17               | -19.7           | 20.31                            | -21.3                              | 21.38                      | 21.64                                   |
| 55                   | 15.96               | 16.3                  | 17.3                 | 20.41               | 19.9            | 20.56                            | 21.6                               | 21.57                      | 21.90                                   |
| 60                   | 16.10               | 16.45                 | 17.4                 | 20.62               | 20.0            | 20.80                            | 21.8                               | 21.70                      | 22.13                                   |
| 65                   | 16.23               | 16.58                 | 17.5                 | 20.78               | 20.1            | 21.02                            | 22.0                               | 21.79                      | 22.33                                   |
| 70                   | 16.34               | 16.64                 | 17.6                 | 20.91               | 20.1            | 21.22                            | 22.13                              | 21.83                      | 22.50                                   |
| 75                   | 16.44               | 16.64                 | 17.6                 | 21.00               | 20.1            | 21.40                            | 22.23                              | 21.83                      | 22.62                                   |
| 80                   | 16.51               | 16.58                 | 17.69                | 21.04               | 20.0            | 21.56                            | 22.28                              | 21.78                      | 22.70                                   |
| 85                   | 16.56               | 16.45                 | 17.70                | 21.05               | 19.9            | 21.69                            | 22.29                              | 21.68                      | 22.74                                   |
| 90                   | 16.58               | 16.3                  | 17.69                | 21.0                | 19.8            | 21.79                            | 22.25                              | 21.54                      | 22.73                                   |
| 1895                 | -16.6               | -16.0                 | -17.7                | -20.9               | -19.6           | -21.9                            | -22.2                              | -21.3                      | -22.7                                   |

## RESULTS FOR GROUP III—Completed.

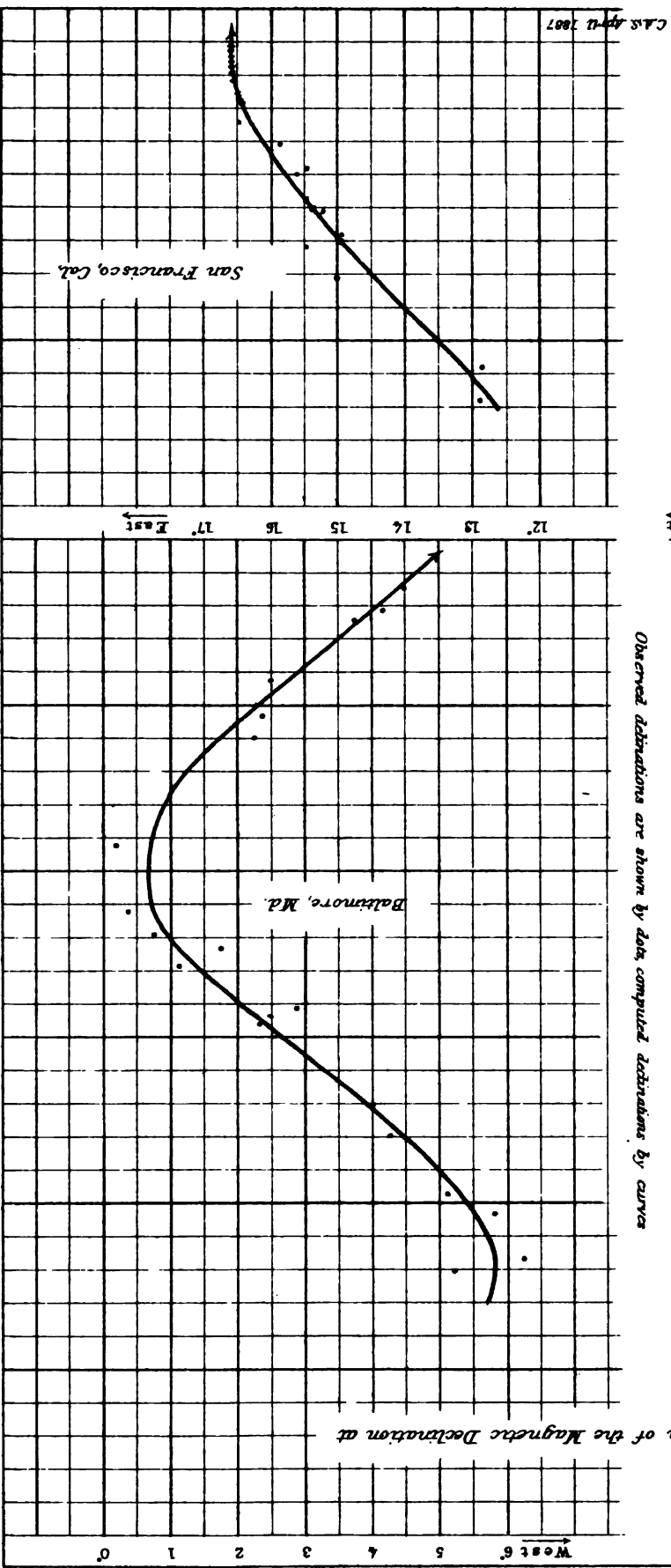
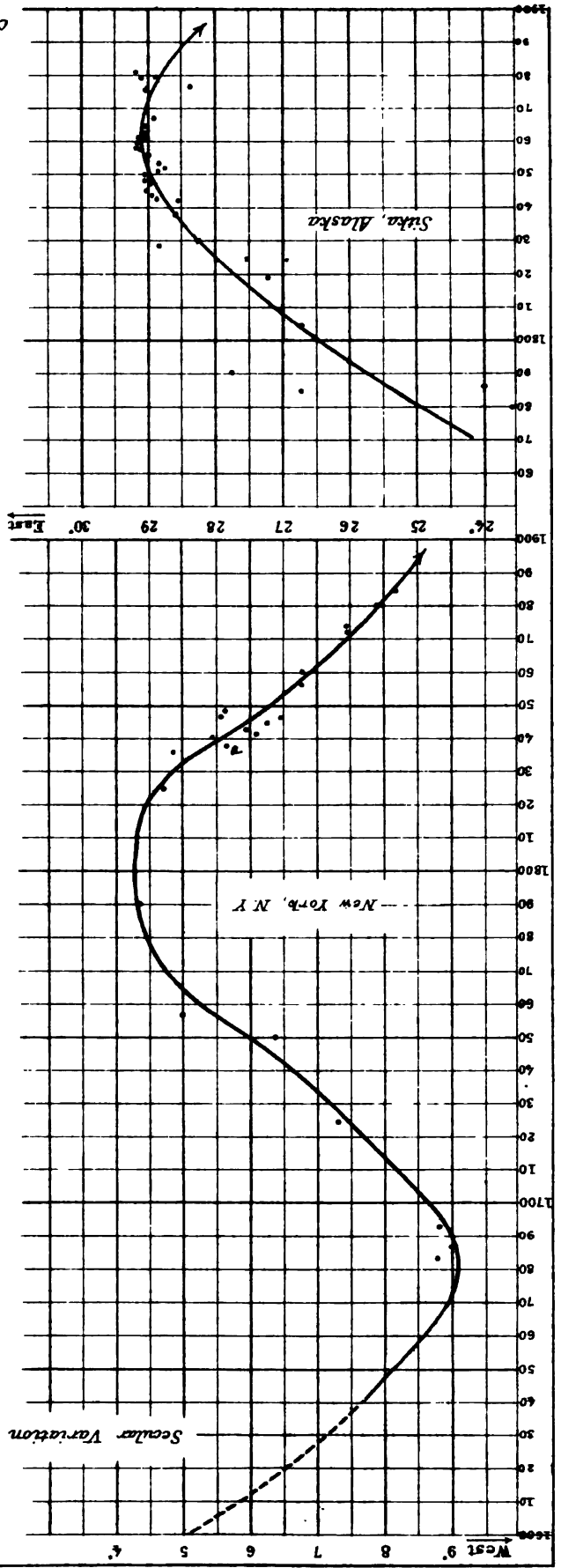
| Year<br>(January 1). | Nootka, Vancouver<br>Island. | Sitka, Alaska. | Port Mulgrave, Ya-<br>kutat Bay, Alaska. | Port Etches, Alaska. | St. Paul, Kadiak Isl-<br>and. | Captain's and Iliuliuk<br>Harbors, Unalashka<br>Island. | Port Clarence, Alaska. | Chamisso Island, Kot-<br>zebue Sound. | Petropavlovsk, Kam-<br>tchatka, Siberia. |
|----------------------|------------------------------|----------------|------------------------------------------|----------------------|-------------------------------|---------------------------------------------------------|------------------------|---------------------------------------|------------------------------------------|
| 1700                 | o                            | o              | o                                        | o                    | o                             | o                                                       | o                      | o                                     | o                                        |
| 10                   | ---                          | ---            | ---                                      | ---                  | ---                           | ---                                                     | ---                    | ---                                   | ---                                      |
| 20                   |                              |                |                                          |                      |                               |                                                         |                        |                                       |                                          |
| 30                   |                              |                |                                          |                      |                               |                                                         |                        |                                       |                                          |
| 40                   |                              |                |                                          |                      |                               |                                                         |                        |                                       |                                          |
| 50                   | ----                         | ----           | ----                                     | ----                 | ----                          | ----                                                    | ----                   | ----                                  | ----                                     |
| 60                   |                              |                |                                          |                      |                               |                                                         |                        |                                       |                                          |
| 70                   | -18.6                        | -24.2          | -22.7                                    | -22.5                | -22.2                         |                                                         |                        |                                       | -6.3                                     |
| 80                   | 18.8                         | 24.9           | 24.5                                     | 24.4                 | 23.4                          | -18.6                                                   |                        |                                       | 6.26                                     |
| 90                   | 19.2                         | 25.7           | 26.2                                     | 26.16                | 24.5                          | 19.0                                                    |                        |                                       | 6.06                                     |
| 1800                 | 19.6                         | 26.41          | 27.82                                    | 27.84                | 25.54                         | 19.32                                                   | ----                   | ----                                  | 5.72                                     |
| 10                   | 20.1                         | 27.12          | 29.25                                    | 29.28                | 26.37                         | 19.56                                                   |                        |                                       | 5.25                                     |
| 20                   | 20.7                         | 27.76          | 30.41                                    | 30.44                | 26.98                         | 19.73                                                   | -26.6                  | -31.1                                 | 4.69                                     |
| 30                   | 21.3                         | 28.31          | 31.24                                    | 31.22                | 27.32                         | 19.82                                                   | 27.0                   | 31.3                                  | 4.06                                     |
| 40                   | 22.0                         | 28.72          | 31.71                                    | 31.58                | 27.38                         | 19.75                                                   | 26.9                   | 31.1                                  | 3.39                                     |
| 50                   | 22.54                        | 28.99          | 31.78                                    | 31.50                | 27.15                         | 19.71                                                   | 26.4                   | 30.5                                  | 2.72                                     |
| 55                   | 22.80                        | 29.06          | 31.66                                    | 31.30                | 26.93                         | 19.63                                                   | 26.0                   | 30.1                                  | 2.40                                     |
| 60                   | 23.05                        | 29.09          | 31.45                                    | 30.99                | 26.65                         | 19.53                                                   | 25.6                   | 29.6                                  | 2.08                                     |
| 65                   | 23.27                        | 29.08          | 31.14                                    | 30.59                | 26.31                         | 19.41                                                   | 25.0                   | 29.0                                  | 1.79                                     |
| 70                   | 23.47                        | 29.02          | 30.74                                    | 30.09                | 25.90                         | 19.27                                                   | 24.4                   | 28.3                                  | 1.51                                     |
| 75                   | 23.63                        | 28.92          | 30.26                                    | 29.49                | 25.45                         | 19.11                                                   | 23.7                   | 27.6                                  | 1.26                                     |
| 80                   | 23.77                        | 28.79          | 29.69                                    | 28.8                 | 24.96                         | 18.94                                                   | 22.9                   | 26.8                                  | 1.03                                     |
| 85                   | 23.88                        | 28.6           | 29.06                                    | 28.1                 | 24.4                          | 18.75                                                   | 22.1                   | 26.0                                  | 0.84                                     |
| 90                   | 23.95                        | 28.4           | 28.4                                     | 27.3                 | 23.9                          | 18.56                                                   | 21.2                   | 25.2                                  | 0.7                                      |
| 1895                 | -24.0                        | -28.2          | -27.6                                    | -26.4                | -23.3                         | -18.4                                                   | -20.4                  | -24.3                                 | -0.6                                     |

## GRAPHICAL ILLUSTRATION OF THE SECULAR VARIATION.

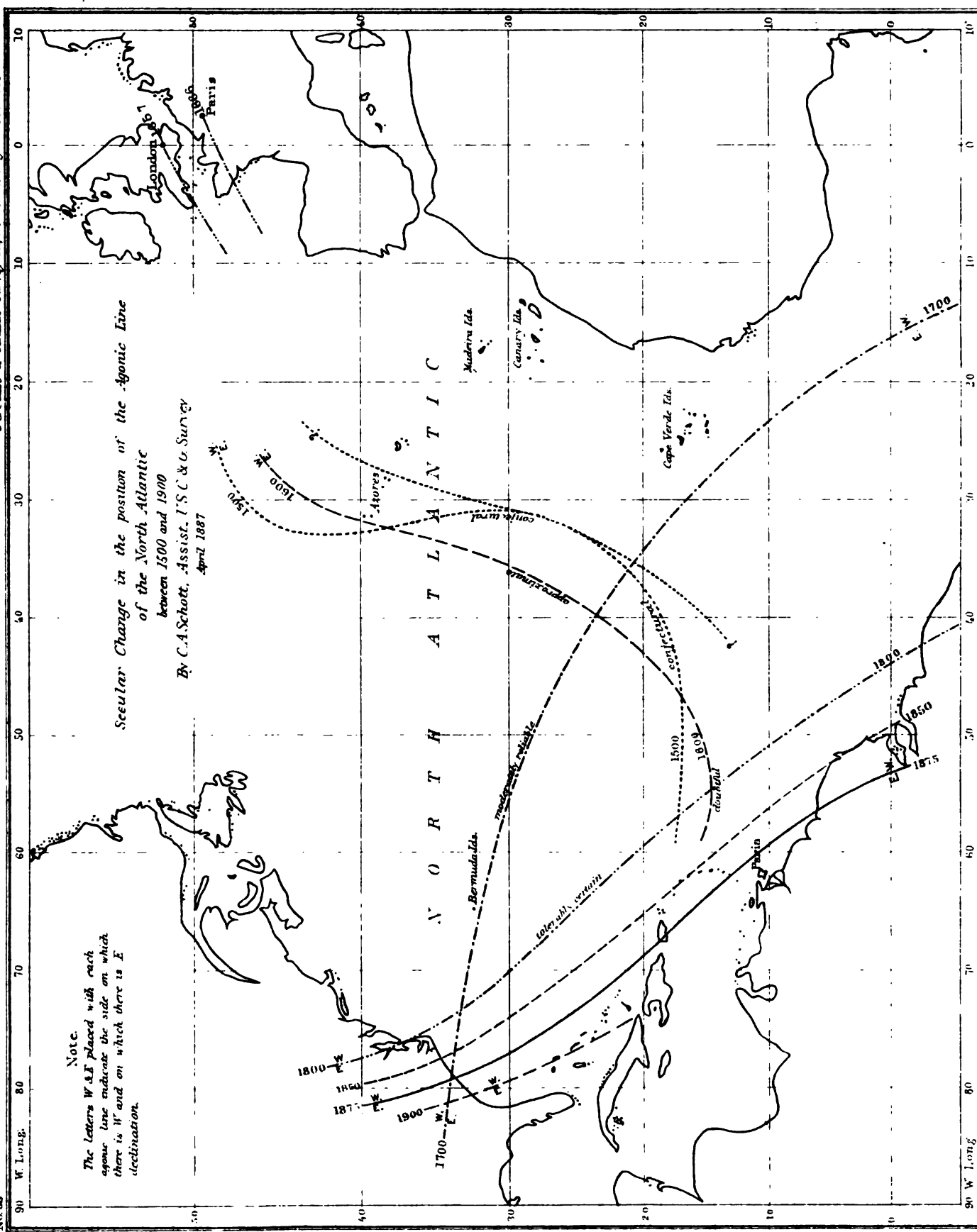
In a preceding part of this paper we have already made use of the graphical method to exhibit to the eye the motion of the needle as observed at Paris, and since this kind of representation has the great advantage of readily impressing the facts on the memory and of affording easy comparisons and generalizations, the secular motion as observed at four leading stations is introduced on plate No. 31. These stations are New York, Baltimore, San Francisco, and Sitka. As an aid to mnemonics on the diagrams, the degrees of easterly declination are shown to increase toward the right or east, and consequently the degrees of westerly declination increase towards the left or west, the ordinates being considered as directed north and south (true); the time scale increases downward where additional observations can be plotted more conveniently than on the top. The observed declinations are shown by dots, the computed declinations by a continuous curved line. These diagrams show in a conspicuous manner the great regularity and persistency of the secular variation, and thus impress the mind with the fact that the explanation of it must ultimately be referred to forces of a periodic character simultaneously acting over large areas and with great regularity, and probably having their source directly or indirectly in the sun, and with a probable dependence on planetary configurations. The effect of these deflecting forces on the magnetic condition at points on the earth's surface undergoes modifications as manifested in the observed variations of the amplitude and in the duration of the secular oscillation at places geographically widely distributed. So far, however, we are not in possession of any theory or even of a plausible working hypothesis as to the true cause or origin of the secular variation, and consequently are constrained to pursue the inquiry empirically by means of observation and discussion.

On map No. 32 we give the annual change of the declination for the epoch 1890, for all places discussed and falling within the limits of the map. The numbers are expressed in minutes of arc, and are directly taken from the preceding tables. A plus sign indicates increasing west or decreasing east declination, as the case may be. To know where the declination is west and where it is east, the agonic line (or line of no deviation) for 1890 is introduced; for all places to the right, or to the north and east, of this line the declination is west at that epoch, and for all places to the left, or to the south and west, of it, it is east at that time. The map also shows the positions of this agonic for the epoch 1795, at which time it had about reached its extreme northeastern position, having come up from the southward; apparently it rested here a few years and then commenced to retreat over its previous course. At that time, in this vicinity, it passed between Washington and Baltimore, and extended out to sea just south of Cape Henry, Va. It is not easy to determine the exact time of stationary condition; there may be an uncertainty of several years in consequence of the ordinary irregularities in the direction of the needle and the extreme smallness of the secular effect, which is overlaid and hidden by the former. There are likewise shown the positions of the agonic line for the epochs 1850 and 1875, and it is hardly necessary to remark that while about 1795 its geographical change was nil, its rate of change southward along our Atlantic coast has continually been increasing; it will reach a maximum at the time of the middle of the secular swing. It will be noticed that for nearly the whole of the United States (within the limit of the map) the annual change has a positive sign; in other words, the north end of the needle moves westward, increasing west or diminishing east declination, and the same is true for Alaska; but there are two regions of exception where the opposite of this motion is observed, viz, one in the extreme northeast, outside of our territory, in Newfoundland and part of Nova Scotia, the other in the extreme west, which is less accurately known than the other in consequence of its great extent over a comparatively little explored area between Mexico and British Columbia. Shaded bands on the map indicate the boundaries of the opposite regions within which the north end of the needle moves in opposite direction, hence these bands occupy places where, in 1890, the needle will have apparently ceased to move, or will have assumed, temporarily, a stationary condition; *western* elongation having been reached at all places within the Nova Scotia belt, and *eastern* elongation at all places within the western coast belt. These bands, like the agonic or any other isogonic curve, continually and gradually shift their position, to which circumstance we shall presently recur. It would not be difficult to construct curves of *equal annual change* for any given epoch, as was done by the writer for a limited area (Coast Survey Report for 1865, plate No. 28), in which system the above belts would form the zero lines, but the subject is sufficiently plain without









such aid. The line of maximum annual change might be expected to lie geographically midway between the two zero regions, which we find roughly to be the case.

On plate No. 33 an attempt is made to exhibit the changes which the (so called) agonic line of the North Atlantic has apparently undergone since its first discovery by Columbus in 1492.\* It shows the several positions of that line for the epochs 1500, 1600, 1700, 1800; also for 1850, 1875, and for 1900 prospectively. The earliest position is quite conjectural, and rests on the observation of Columbus for its place in the mid-Atlantic, and for a second point on it, farther north, on an observation by Sebastian Cabot.† We also have reason to suppose the line to have passed over a region in the vicinity of Paris, and over a region including the Antilles. The second position, that for 1600, is taken from Hansteen's work (of 1819) and may be considered as a rough approximation; some change was made by me at its western end. The position for 1700 is more reliable, since it depends directly on numerous observations collected by Halley; it is taken from his chart. The positions for 1800 and 1850 require no further explanation; that of 1900, though prospective, is quite certain, considering the small scale of the map.

Upon the whole the general direction of the isogonic system in the vicinity of the agonic line of the North Atlantic appears to have been swaying forward and backward in a rather irregular way, with a preponderance, after 1600, toward a direction like that in which astronomical azimuths are counted.

*Progressive change in the secular variation.*—The progressive change noticed when examining at different times the position of the lines where the needle has arrived at elongation or at extreme range in the secular motion has already been referred to in a general way, and the systematic propagation of the phase of *eastern* elongation across the United States, from the Atlantic to the Pacific, in about the lapse of a century, has been adverted to. Under the present heading it is proposed to enter somewhat more minutely into this remarkable phenomenon.

The following figures are taken directly from our table, column headed "Nearest epoch of *east* elongation," and beginning in the extreme northeast we find the years of occurrence of this stationary phase of east elongation at different localities as follows:

|                                       |      |                                       |                  |
|---------------------------------------|------|---------------------------------------|------------------|
| Halifax, N. S. . . . .                | 1713 | Marietta and Cincinnati, Ohio . . . . | 1815             |
| Eastport, Me. . . . .                 | 1749 | Florence, Ala. . . . .                | 1821             |
| Portland, Me. . . . .                 | 1778 | St. Louis, Mo. . . . .                | 1820 (?)         |
| Boston and Cambridge, Mass. . . . .   | 1780 | Chicago, Ill. . . . .                 | 1832             |
| New Haven and Hartford, Conn. . . . . | 1800 | Salt Lake, Utah. . . . .              | 1873             |
| New York, N. Y. . . . .               | 1799 | Vancouver, Wash. T. . . . .           | 1883             |
| Philadelphia, Pa. . . . .             | 1802 | Cape Mendocino, Cal. . . . .          | 1886             |
| Pittsburgh, Pa. . . . .               | 1808 | San Francisco, Cal. . . . .           | 1893 (Computed.) |

\* For particulars see two papers in Coast and Geodetic Survey Report for 1880, viz: Appendix No. 18: "An attempt to solve the problem of the first landing place of Columbus in the New World," by Capt. G. V. Fox, Assistant Secretary of the Navy, 1861-'66; and Appendix No. 19: "An inquiry into the variation of the compass off the Bahama Islands at the time of the landfall of Columbus, in 1492," by Charles A. Schott, Assistant Coast Survey. In connection with this subject it may be remarked *en passant* that, in the writer's opinion, the controversy about the first landing place, and the track of Columbus among the West India Islands, may now be considered as closed (save the identification of the first harbor in Cuba) by the recent labors of Lieut. J. B. Murdock, U. S. N.: "The Cruise of Columbus in the Bahamas, 1492." The landfall took place, undoubtedly, at Watling's Island, as insisted upon by Captain Becher, in 1856, but in attempting to trace the *subsequent* track he failed, in consequence mainly of an erroneous assumption of the magnetic declination prevailing at the time of Columbus.

† Soon after the discovery by Columbus of a point of no variation in the Atlantic, Sebastian Cabot discovered a second one farther north, and evidently belonging to the same agonic curve. Livio Sanuto states, in his *Geographica Distincta* (Venice, 1588), that he procured the information from Sebastian Cabot and made use of his map (probably that composed in 1544), on which the position of the meridian intersecting the point of no variation was seen to be one hundred and ten miles to the *west* of the island of Flores, one of the Azores; see "Narrative and Critical History of America," by Justin Winsor, Vol. III, Boston and New York, 1884, p. 41. This discovery probably was made on the second voyage of the Cabots, or in 1498, although it may have been noted in the first, in 1497, by the elder Cabot. The latitude of the point is uncertain, but may be approximated from the fact that in the first voyage land was apparently sighted at Cape Breton, and in the second the coast of Newfoundland (Baccalaos), which is said to have been made from the north.

In the course of a conversation with Contarini, the Venetian ambassador to Charles V, in 1522, Sebastian Cabot told the ambassador that he had a method for ascertaining, *by the needle*, the distance between two places from east to west, which had never previously been discovered by any one. *Ibid.*, p. 50.

In this idea, however, he was also anticipated by Columbus.

These places and corresponding times suffice to bring into strong relief the gradual progress within our geographical borders of what may aptly be called the crest (or hollow, as we may conceive) of the magnetic secular wave clear across the North American continent in about a century's time. This transfer of the eastern-elongation phase thus took place from east to west across the country; hence it is highly probable and may reasonably be inferred that with the present passing out into the Pacific of the eastern-elongation phase and the coming in of the opposite or western-elongation phase in the east, this invasion of the latter phase, already commenced in Northeastern Maine, will likewise propagate itself in the course of time over and across the continent; in fact our formulæ do suppose this to take place. The question whether our table of dates of the eastern-elongation phase can be extended so far east as to reach Europe cannot be definitely answered. We have for St. John's, Newfoundland, the date of 1741, and for Paris the year 1581, for the epoch of this phase, but unfortunately no intermediate stations at which to follow up the motion; observations at the Azores, in southern Greenland, and in Iceland may possibly come to light to assist in this inquiry.

If we follow up the dates of the eastern magnetic elongation going south along our Atlantic coast, thence across the Gulf of Mexico and north along the western coast, we notice the same law of gradual change as in our first table. A curve of equal date would fairly run parallel to our Atlantic coast line, and hold even as far south as Havana and Panama; similarly a curve of equal date on the western coast from Lower California up to the Straits of Fuca would not greatly deviate from it.

|                                          |      |                                     |                  |
|------------------------------------------|------|-------------------------------------|------------------|
| Charlottetown, Pr. Ed. Island . . . . .  | 1734 | City of Mexico . . . . .            | 1848             |
| Eastport, Me. . . . .                    | 1749 | San Blas, Mex. . . . .              | 1861             |
| Nantucket, Mass. . . . .                 | 1769 | Santa Barbara, Cal. . . . .         | 1893 (Computed.) |
| Cape Henlopen, Del. . . . .              | 1801 | Seattle, Wash. T. . . . .           | 1883             |
| Charleston, S. C., and Savannah, Ga. . . | 1794 | Nee-ah Bay, Cape Flattery . . . . . | 1887             |
| Havana, Cuba . . . . .                   | 1797 | Nootka, Vancouver Island . . . . .  | 1898 (Computed.) |
| Vera Cruz, Mex. . . . .                  | 1828 |                                     |                  |

Beyond Vancouver Island and as we enter Alaska the dates again become earlier, as at Sitka, 1861, and in the whole region to the northward and westward, and including the chain of islands, the average date probably varies between 1830 and 1840 or thereabout. Near the eastern coast of Asia, west of Kamtchatka, we encounter a complex system of isogones whose secular development, however, lies outside the limits of our research.

With respect to secular variation, then, our magnetic weather is coming in from the northeast, and we already note the past occurrence of the western-elongation phase at Newfoundland in 1870, and at Prince Edward Island in 1884, with its expectation at Halifax in 1893, at Eastport in 1899, and at Portland in 1913. Should the Paris date 1812 be connected with this, the speed across the Atlantic must have been very different from that of the earlier east-elongation phase; all this, however, is at present matter of speculation.

Looking over the numerical values of  $\alpha$ , on which the length of the period depends, we notice a relation to geographical position, as in the case of the epochal quantity  $c$ , of our general formula, just considered, but less marked.

For stations on our Atlantic coast the values  $\alpha$  are generally included between 1.30 and 1.55, implying periods of 277 and 232 years respectively, and the same limits will apply to the generality of places in the interior.

For stations south of the United States the value of  $\alpha$  is decidedly less, as at Kingston, Panama, Acapulco, City of Mexico, for which  $\alpha$  varies between 1.0 and 1.1, with corresponding periods of 360 and 327 years. The value of  $\alpha$  for western coast stations, as San Diego, Santa Barbara, Monterey, San Francisco, and Cape Mendocino, remains low, averaging 1.15 (period 313 years); in Alaska it rises again to about 1.30 (period 277 years), with but little variation.

At first sight this diversity in the length of the period would seem to present a great obstacle in the way of explaining the cause of the secular variation through the action of an external or cosmical disturbing force which would be supposed to act alike at all stations. If we suppose the changes in the direction of the magnetic needle to be due to changes in the direction of electric currents or of electric impulses or waves traversing the earth's crust and permeating the same to a considerable depth, and altering by inductive action the magnetic condition of the earth itself,

we may see in the diversity of the length of the period, and of the magnitude of deflection at different places, the effect of a systematic *swaying* in the position and intensity of such electric currents.

For the further development of the laws of secular variation in North America it would be of great importance to know what has been going on in the immediate vicinity of the magnetic pole (where the dip is  $90^\circ$  and the horizontal force zero) since Ross visited the region, now more than half a century ago. We have no direct or observational evidence whatever whether the pole remained stationary or has shifted its position, and if the latter, how much and in what direction.

In conclusion a few remarks may be made respecting the accuracy of the observations, shown in the tabular values of probable errors as derived from the differences of observed and computed values.

The probable errors of observation given in the tables will serve to convey some idea of the relative value of each series of observations. The imperfections in the instrumental means and methods of the older observations in many cases react unfavorably on the modern observations, which are made with more precise instruments and by more refined methods. If we take, for instance, the observations of Hudson, made in 1609, in the vicinity of New York, we find each fairly chargeable with a probable error of about  $\pm 3$  or  $4^\circ$ . While these observations are very imperfect, those of Champlain of about the same period (1604 to 1612) are no better. These two navigators differ nearly  $9^\circ$  off the mouth of the Penobscot, Maine, and nearly  $12^\circ$  off Cape Cod. The observations made by Vancouver on our western coast, between 1792 and 1794, are each subject to a probable uncertainty of  $\pm 1^\circ$ , and even in our own days it requires very favorable circumstances to determine the variation of the compass at sea with a probable error of say half a degree or less. Increased precision was attained with the improvement of the azimuth compass and by allowance for disturbing effect of the ship's iron, and, with respect to shore stations, greater accuracy was obtained by the introduction of the theodolite for determining the astronomical meridian. With a portable magnetometer and a collimator magnet, the instrumental means need not introduce a greater uncertainty than about one minute; but the actual probable error of any determination is dependent also on the irregular variations in the direction of the magnetic force from day to day, thus making it desirable and indispensable for precise work to continue the observations for three or more days and to correct the individual results for diurnal variation. The amount of the probable error of an observed declination depends also on the intensity of the horizontal component of the magnetic force at the place, *i. e.*, in general the smaller the horizontal force the larger the apparent probable uncertainty.



